Engineering
Library

SEP 26 1921

September 22, 1921

Engineering News-Record

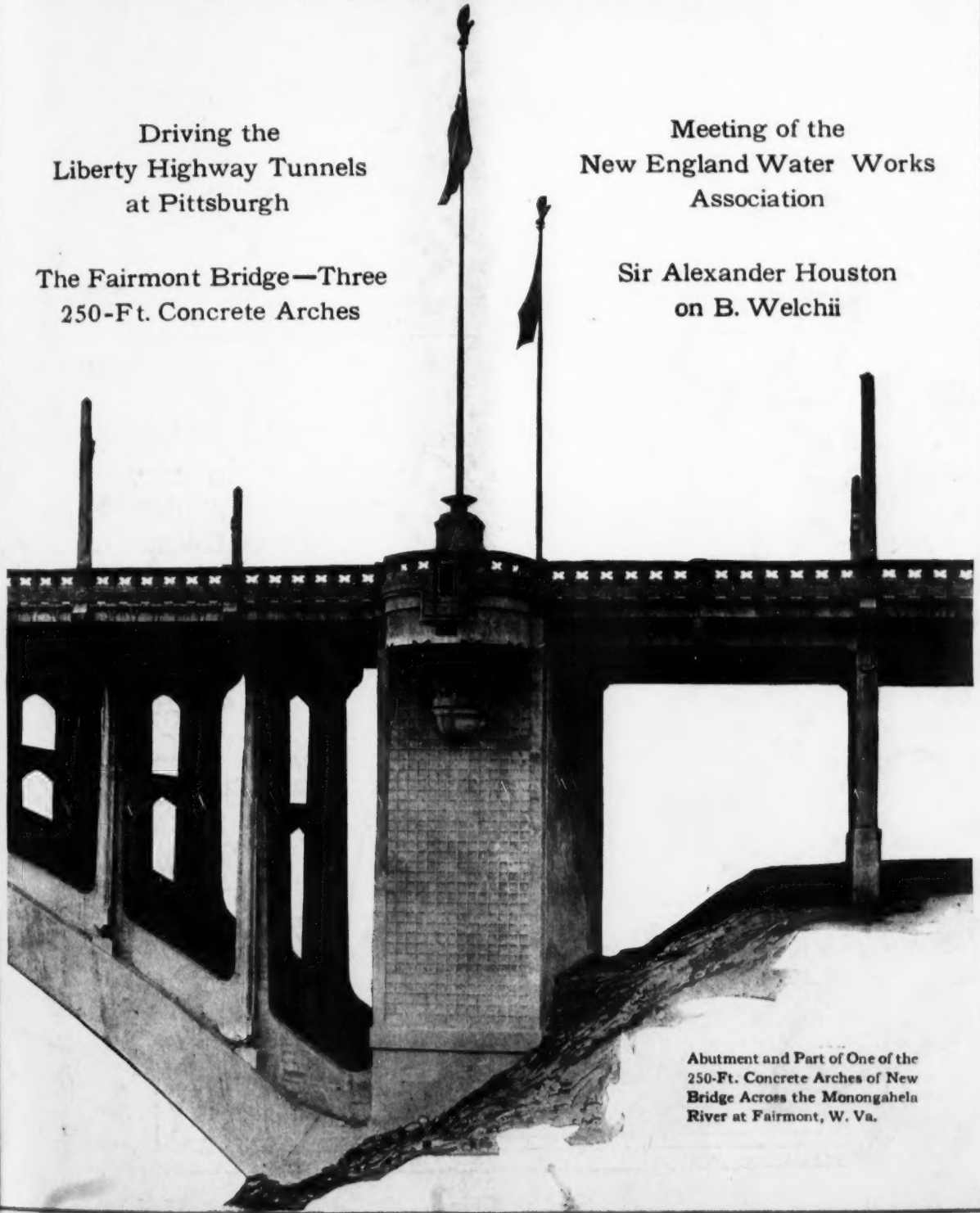
Devoted to Civil Engineering and Contracting. McGraw-Hill Company, Inc.

Driving the Liberty Highway Tunnels at Pittsburgh

The Fairmont Bridge—Three 250-Ft. Concrete Arches

Meeting of the New England Water Works Association

Sir Alexander Houston on B. Welchii



Abutment and Part of One of the 250-Ft. Concrete Arches of New Bridge Across the Monongahela River at Fairmont, W. Va.

Griffin Wheel Plant of the American Steel Foundries Company, Council Bluffs, Iowa.

One of the six plants of this company where Federal Cement Tile Roofs are in use.

There are thousands of Federal Cement Tile Roofs in use. Each roof is a Federal Representative. Ask to see some of the installations in your neighborhood and learn from your own inspection and from personal interviews with owners the story of Federal Roof performance. Fifteen years experience of a trained organization specializing in the manufacture and erection of Federal Cement Tile is your Roof Insurance.

"The Indestructible Roof"

FOR FLAT and PITCHED SURFACES

Made, Laid and Guaranteed by

FEDERAL CEMENT TILE COMPANY

110 S. DEARBORN ST.

CHICAGO

HAMMOND, INDIANA ——— Works ——— DETROIT, MICHIGAN

A Consolidation of Engineering News and Engineering Record — McGraw-Hill Company, Inc.—JAMES H. McGRAW, President

ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING
AND CONTRACTING

E. J. MEHREN
Editor

Volume 87 — NEW YORK, SEPTEMBER 22, 1921 — Number 12

Twenty-Two Times Mayor

DEPLORABLE as are political conditions in many American cities, refreshing instances of retaining efficient men in office present themselves now and then. A case of the sort has come to public attention in New Bedford, Mass., where Mayor Ashley has announced that he will not stand for office again after finishing his twenty-second term as mayor. Elsewhere we print a short appreciation of Mayor Ashley by a man who has served New Bedford faithfully and well even longer than has Mr. Ashley and who is well known to many of our readers, R. C. P. Coggeshall, superintendent of waterworks.

Amateurs or Experts

AFTER serving eight years as a city councilman and then six years as mayor of Cumberland, Md., Thomas M. Koon believes that the city would be better governed if instead of paying five commissioners a total of $6,300 a year to act both as legislators and heads of city departments, $10,000 a year were paid to a city manager and nominal compensation to the commissioners, the latter to have legislative powers only. This is common sense. It is the basic principle of the commission-manager plan. It accords with the ideas so lucidly expressed fifty years ago by John Stuart Mill in his essay on "Representative Government." The plain commission plan gives our cities amateurs as heads of the leading city departments and pays them money enough to hire or go far towards hiring an expert chief administrator. The choice lies between city administration by amateurs or by experts.

British Population Figures

LIKE the Borough of Manhattan, New York City, in our census of 1920, the population of what is known as the Administrative County of London shows a decrease in population, although a lighter one, for the decade just passed. The figures are those of the new British census. Greater London, as did New York City as a whole, shows an increase in population in the past decade, but a very much smaller one—Greater or Police London is not strictly comparable with New York City since the former includes many municipalities entirely independent of the Administrative County. For Great Britain (England, Scotland and Wales) the population gain for the past ten years, as was to be expected, is small and the excess of females over males has materially increased—both penalties of the war. In the Empire, Australia and New Zealand show large gains, as presumably Canada will when her 1921 population is announced. Stupendous is the word required to characterize the population of India, now 319,075,132, particularly if one reflects on what this would mean if its people consumed manufactures in the same ratio as Great Britain, Canada and the United States.

Successor to the Alchemist

THE CHEMIST is the lineal successor of the alchemist, and to the layman is still enshrouded with some of the mystery of his predecessor. He puts two substances, quiescent when alone, together and, calling on mighty forces, produces a new substance unlike either of the others, often accompanying the transformation with spectacular evidences of high temperatures. Possibly it is to the mysterious and awe-inspiring character of some of his work—though skillful publicity methods are not neglected by the wise chemists—that the American Chemical Society's annual meeting usually gets a large amount of space in the public prints. In any event, the result is good for the chemist—and his brother, the engineer—in that there results a better understanding by the public of the functions and work of those who develop new uses of the forces of nature. Incidentally, engineers can learn something about the handling of publicity by noting how the chemists ease the newspaper man's task by assisting in translating highly technical data into every-day language.

Rattler Tests for Road Concrete

USING spherical test pieces the Kansas Highway Commission appears to have developed a successful rattler test for concrete for pavement. Previously special apparatus, requiring too much room for laboratory use and involving time and expense which few highway departments could afford, has been considered necessary to obtain definite information on the resistance to wear of concrete paving mixtures. The Kansas test, if it bears out its present promise, puts the determination of wear into the laboratory, with apparatus already available. This is a distinct improvement. While, with the increasing use of rubber-tired vehicles, resistance to abrasive wear is not the critical factor that it was, it is still a factor which cannot be neglected in concrete road design. Tractor traffic and horse-drawn steel-tired vehicles still have a large place on paved roads particularly in the farming states of the Middle West. Abrasive strength, therefore, is not a negligble function of traffic endurance.

Penalty of Botch Work

FROM last week's accounts of the shocking bridge accident at Chester—based on expert scrutiny of the conditions—it is difficult to conclude otherwise than that the cracked gusset-plate which tore apart under the weight of a crowd existed in its cracked condition ever since the sidewalk bracket had been "repaired" after being damaged in a boat collision. It survived during a number of years only by luck. Crowds dense enough to produce a loading of 100 lb. per square foot, conventionally taken as a maximum in design, do not occur often, but in the course of time they do happen.

The time came for this particular bracket, with a result determined by the cracked plate, which somebody's conscience had allowed him to slip back into place. The blame for the wholesale drowning does not rest on the crowd, or the age of the bridge, or the material of the plate, or the design—faulty though this was—but solely and alone on the man who botched the repairs. We may each feel content in the possession of a conscience that is proof against the temptation to do a like bit of work. But the case with its score of dead emphasizes by a tragic warning the special sin of botching at a hidden point.

The Hudson Tunnel Deadlock

JUDGED by the events of the past few months political bickering gives promise of delaying the completion of the Hudson River vehicular tunnel considerably beyond Dec. 31, 1924, the date announced by the chief engineer in his report for 1920. There is no justification for the set-back, for the engineering staff, having brought the designs and specifications for the subaqueous work to the verge of completion, has been ready for some time to place the work under contract. The holdup seems to be chargeable to the tactics of the New Jersey commission.

That body first showed its hand in an attempt to barter approval of a shaft contract at the west end of the tunnel for a lavish program of street widening in Jersey City in which the New York commission refused to concur. Then came the summary "dismissal" by the Jersey commissioners of the board of consulting engineers, the New York commission again refusing to sanction the arbitrary and unexplained action of its confreres from across the Hudson. Now it appears that the work on the Jersey side is to continue indefinitely in the doldrums by reason of the Jersey commission's insistence on a perpetual easement for a railroad siding flanking the proposed tunnel entrance plaza. This petty squabbling has already held up the award of the Jersey shaft contract for five months (it was first publicly advertised last March) and a beginning on the real job of tunneling under the river is not yet in sight.

What the delay means can best be indicated by reference to the chief engineer's estimate of income from vehicle tolls and electric conduit rentals. In the tunnel report dated Dec. 31, 1919, it was estimated that the first year of tunnel operation would produce an income of $2,500,000. On this basis every month's delay in completing the project means a loss of more than $200,000.

But this is not the only loss. The New York district, in common with other sections, faces an unemployment problem. On the Hudson tunnel, involving an expenditure of nearly $30,000,000, a large force of both skilled and unskilled labor could find work, not merely under the river but also in the many industries which would supply the equipment and materials for the twin tubes. Ample funds for beginning construction have been provided, the engineering plans and specifications are ready, labor is seeking employment, and an impatient public is eager for the opening up of the subaqueous vehicle route which will facilitate the movement of freight, foodstuffs and passengers between the two states. In the face of these arguments for immediate action the New Jersey commission, ignoring responsibilities for public service, fails to rise above the level of political dickering.

A continuation of the tunnel deadlock should no longer be tolerated. If the New Jersey commission, as now constituted, cannot produce action, its members should be removed and replaced by others with a broader conception of their functions and with private interests affected neither directly nor indirectly by the location or the construction of the under-river tubes.

Study of Spore Formers in Water

OF THE MANY good points in Sir Alexander Houston's article on "B. Welchii, Gastro-Enteritis and Water Supply," published elsewhere in this issue, none deserves more attention than the one on the desirability of comparative studies of spore formers in the water supplies of the United States and Canada. That he lays stress on the whole group of spore formers rather than on B. Welchii alone follows naturally from his own studies of a similar if not identical germ and is in accord with the consensus of opinion expressed in our issues of June 2 and 9 by 66 water analysts and sanitarians of the United States and Canada. Nearly the whole 66, like Sir Alexander, are skeptical as to B. Welchii being the cause of diarrhea or other water-borne intestinal disturbances but many of them, like him, are on the alert for new and convincing evidence on the subject. At the same time he and the others broaden the chances for new discoveries by holding all the spore formers open to indictment, rather than B. Welchii alone.

That Sir Alexander should think conditions for such broad exploration of the entire field of spore formers are more favorable in the United States and Canada than in Great Britain is not wholly complimentary to water-works on this side of the ocean, since the assumption rests on the belief that many of our supplies, as delivered to consumers, are inferior to the British in sanitary quality. This inferiority, it appears, he attributes largely to our use of mechanical rather than slow sand filtration, when there is any filtration, and to our reliance upon chlorination, both to make up what he considers to be deficiencies in our mechanical filter plants and, worse yet—from his and the European viewpoint generally—our use of surface supplies with no treatment safeguard except chlorination. This line of reasoning, besides being an argument for comparative studies of spore formers, should set many of our cities and towns to thinking of the dangers they run if (1) they go easy on filtration and rely too much on chlorination and if (2) they depend wholly upon such protection as is afforded by chlorination alone. In passing, it may be noted that apparently Sir Alexander, in common with many other trans-Atlantic water experts, does not fully realize that when Americans speak of a mechanical filtration plant they mean one that includes pre-coagulation and not merely a rapid as contrasted with a slow sand filter.

To carry out properly what we understand is his conception of comparative studies of spore formers would require co-operation between a number of water-works having supplies of diverse character and treatment, preferably with state and federal co-operation. Such studies in the United States and Canada are highly desirable, but would take years.

Meanwhile, we join with an undoubtedly large majority of American and Canadian water-works men in agreeing with Sir Alexander that the B. Welchii test still stands supreme.

Economic Limits of Flood Protection

IN THE face of the destructive floods that have been reported within the past few months it needs no prophetic gift to foretell that the near future will see much development of flood-protection work. Such happenings as the floods at Pueblo and in the southern Texas region rouse a spirit that demands that recurrence of destruction be prevented. It is known that engineering works can be provided to prevent or minimize damage by flood, and every flood-stricken community will demand that such works be constructed for its benefit. In fact, study has already been begun at Pueblo, while Phoenix has decided upon the construction of protective works even before its recent visitation. But interest in the subject is sure to engage a much wider field than merely that of the communities which have just suffered loss. The events of the current year demonstrate impressively that the flood menace is widespread, and that it affects most of all the minor streams, heretofore rarely thought dangerous.

For six or seven years, since the beginning of flood-protection planning in the Central States after the flood catastrophe of 1913, we have been marking time in the matter of giving heed to the danger to which many valley regions are exposed. Even the brilliant pioneer studies made in connection with the Miami River work have received but scattering attention. It was to be expected that this neglect of the subject should be compensated for by a re-awakening interest; all the more remarkable is it that at this time a series of floods is recorded which gives a fresh turn to thought on flood-protection. Instead of exhibiting another great regional storm like that of 1913, they show the danger residing in small-area rainfalls of phenomenal intensity. They bring back to mind the long succession of local-storm floods of earlier years, forgotten in the overshadowing influence of the 1913 flood.

There is little law or system about the occurrence of storms of intense precipitation. From present knowledge we must accept the probability that almost every brook or stream is potentially the path of devastating flood, for no natural channel—the exceptions are few—is capable of carrying the volumes of water poured out by a cloudburst storm. Though doubtless only at exceedingly long intervals, such storms may break anywhere, at any moment. It is this prospect, together with the certainty that flood-protection is worth most if built before a flood, that promises to make it one of the prime fields of public-works engineering in years to come.

Obviously the opportunities for flood-protection are great. Complete protection would require that works be built in every channel subject to flood, and this, as suggested, would mean virtually every stream throughout the country. The total cost of this work, however, would amount to a stupendous total, and every instinct tells us that so great an expenditure for the purpose is altogether disproportionate, that many of the protection projects must surely be unsound.

True progress in this field, indeed, is primarily dependent upon study of the underlying principles of the expediency of flood-protection. What are the economic limits of flood-protection?—that is the essential question. Virtually nothing has yet been done toward such study; even the data for it are lacking or buried in uncoördinated masses of statistics. Yet without it there seems little chance of sifting the good from the bad projects, and assuring the needed development of protective work without wasted expenditure.

Flood-protection is complex. It involves contingencies of wholly uncertain, perhaps speculative, character. Both the cost and the value of the protection are indefinite. It offers a variety of amazingly difficult questions, which, however, require answer, in terms of general principle at least.

The cost of flood-protection is difficult to determine not only because it is dependent on the maximum flood—a future contingency—but also because the investment accumulates at increasing rate by the piling up of interest until a return is earned by the prevention of flood loss. The calculation is closely dependent on the sequence and magnitude of floods, with prime regard, however, for the greatest flood. The value of the protection is a similarly vague quantity.

That the problem is pre-eminently one of financial, or rather economic, analysis is apparent from any one practical instance. When a city visited by flood compiles an estimate of its property losses, and reports a total of say ten millions, every citizen is strongly impressed with the importance of avoiding recurrence of such loss. At the moment, estimates of flood frequency and magnitude are arrived at in the light of the personal misfortune, and no thought is given to the application of meteorological statistics. The processes by which the matter is dealt with are emotional rather than reasoning. An investigation shows, perhaps, that protection can be had for three or four million dollars, and if a vote of the people be taken before the impression of the disaster has faded, the project is sure to receive approval. Yet the fact may be that the flood which did the damage is of less than fifty-year frequency, and then, obviously, the investment of three or four millions would accumulate to ten times that amount before it could yield a return by preventing loss in the next flood. The soundness of the improvement is challenged, and only psychological factors of loss or gain—as restoration of public confidence or improvement of realty values, could reverse the conclusion. But the extent to which these latter factors may properly be taken into account is itself open to question.

First in importance among the many elements entering into the economics of the subject is knowledge of rainfall and flood occurrence. The data available in this field are none too ample, as evidenced by the fact that the recent Texas rains gave figures so high that at first they were rejected as untrue by Weather Bureau officials at a distance—though a higher flood occurred a century ago. But even more lacking is analysis of the existing data. When this is carried to the point of supplying, for example, the definite forecast that a South Dakota valley of 300 square miles may expect flood-storms of such and such intensity at intervals of so and so many years, and when the most probable seasons of these storms are indicated, we will have a tangible working basis for planning the country's flood-protection work soundly.

What has been said might suggest that determination of the economic limits would discourage flood-protection. It would more often tend to stimulate than to discourage we believe. But whatever the effect, the study is necessary, as already indicated, if the work is to develop along sound lines. The main result to be accomplished is to outline the proper scope of flood-protection. We believe it will prove to be surprisingly large.

Concrete Arch Bridge of Three 250-Foot Spans

Long Spans of High-Level Bridge Over Monongahela River at Fairmont Controlled by Required Channel Clearance—Special Architectural Treatment—Three Spans Centered Simultaneously

By E. H. Harder
Assistant Engineer, Concrete-Steel Engineering Co., New York

Until the present year the city of Fairmont, W. Va., had only one highway crossing over the Monongahela River, a low-level steel bridge. As the city is built high up on steep banks, even the tortuous approaches of the trolley and vehicular traffic were too steep to permit using the steel spans to maximum capacity. A new high-level concrete arch bridge completed two months ago remedies these conditions. Its three 250-ft. spans and its architectural development make it a noteworthy structure.

In developing the plans for the new river crossing the designers at first contemplated building a single huge arch across the channel—a 432-ft. span with two cored-out ribs of 95 ft. rise. This design was abandoned because of foundation conditions and cost. A better solution was found in a three-span design. The War Department required a channel clearance height of 50 ft. on a 200-ft. width, which dictated a 250-ft. arch with 52-ft. rise from a springing-line elevation 33 ft. above pool level. By using side spans of the same length all railroad and street limitations on both banks could be met. This arrangement also placed the end arch abutments against suitable rock ledges.

Equality of span lengths is an important feature of the structural design throughout, resulting in marked economy by allowing the use of forms several times and in some instances as many as six times.

Subsoil—The geological conditions are typical of coal-mining country. Rock was found about 15 ft. below pool elevation, covered with sand and gravel varying in depth from a few inches to a few feet. Shot-drill core borings disclosed sedimentary rocks varying from medium hard shales, limestone, etc., to very hard sandstone. Sufficient holes were drilled for each foundation—especially for the river piers—to determine the condition of the various strata, to make certain that each stratum lay in its natural bed, and that there were no breaks or caverns beneath the top layers.

The west pier was founded on solid sandstone about 11 ft. thick, the sandstone lying on top of a stratum of hard, shaly limestone. At the east pier the sandstone stratum feathered out, exposing the upper part of the limestone. In the west abutment sandstone was encountered, while the east abutment was founded on shales and limestones of varying hardness. The piers for the approaches were founded on sandstones and hard shales and, in a few instances, on hard compacted clay.

Arch Design—The three long spans have two ribs, each 14 ft. wide, spaced 14 ft. apart in the clear (Figs. 3 and 4), reinforced with 22 1¼-in. bars 8 in. on centers in both top and bottom. These bars are held in place by structural-steel spacer frames, which also strengthen the rib against shearing stresses. There are also shear bars placed at intervals between the spacer frames.

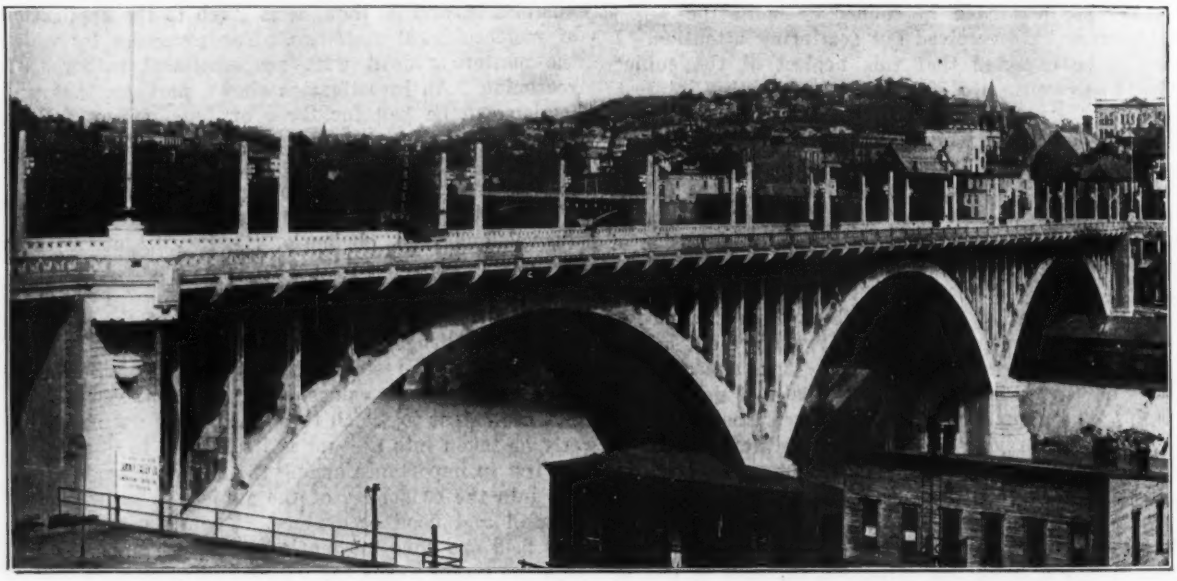


FIG. 1. THREE 250-FT. SPANS OF FAIRMONT BRIDGE, LOOKING WEST

The arches were designed for 150 lb. per square foot on the roadway, and 100 lb. per square foot on the sidewalks. The floor slab and girders under the trolley tracks were designed for 50-ton cars with 25 per cent impact, and under the remainder of the roadway for 150 lb. per square foot or an axle-load of 24,000 lb., with 25 per cent impact.

For slab and girder design the permissible stresses in the concrete were 650 lb. per square inch for compression and 16,000 lb. per square inch tension in the steel; for the arches, 750 lb. per square inch for compression in the concrete, which included temperature stresses for a total range of 50 deg. F.

Strain-gage Observations—To obtain greater certainty regarding the stresses in the arch ribs, the designers carried out an extensive program of strain-gage measurements on the arch reinforcing at various points, as well as on the concrete at the crown and haunches of two of the arches. These measurements, together with extensive temperature measurements of the interior of the arch concrete, were undertaken primarily to determine the magnitude of temperature stresses. While their data are not available for publication at this time, it can be said that the strain-gage readings show higher stresses in the steel than those calculated by the usual methods of arch design.

Supporting the floor system above the arch ribs are slender transverse walls 16 ft. apart, connected at the top by girders with curved bottom line. Cantilevers cast with this girder section, overhanging 8 ft., support the sidewalks. Each cantilever is tied into both wall and girder with six 1-in. bars, because of notching for a water main and a conduit tunnel. The brackets, shaped to an ellipse from a wall capital to a point from which a curved return of short radius is made to the post unit of the parapet, give a most solid and at the same time graceful effect.

The floor slabs are continuous over three spans between expansion joints, spaced generally 48 ft. apart and located over transverse walls. The 3-in. slab forming the bottom of the conduit tunnel was cast in short sections off the job and later set in place. The 5-in. slab covering conduit tunnel and water main was cast in place in short sections, for facility of access. The sidewalk slab, 7-in. thick, was designed as simply supported in order to lessen the possibilities of cracking near or over supports; a single layer of triangle-mesh wire fabric was placed near the upper surface of the sidewalk slabs to prevent further any cracks from appearing.

Over the main abutments the roadway and sidewalks are carried by a house-like structure which rests on top of the solid concrete arch abutments. This house consists of four concrete walls with floors about 12 ft. apart. Windows, doors and stair wells are provided to make these floors useful. Access to the stair wells from the top of the bridge is by way of a circular balcony projecting from the outer wall. It is intended to build a comfort station on the top floor of the west abutment pier, while the other floors will later be utilized by the street and water departments of the city.

Architectural Features—The appearance of the bridge was of primary importance, but, while the architectural treatment was designed to ornament the structure, in no manner did it interfere with economy or the demands of good engineering. It was early planned to abandon the conventional style of building longitudinal face walls over the river piers to make such piers seem solid up to the roadway. Instead, a simple and uniform treatment of fascia girders and parapets in the 16-ft. spacing of transverse spandrel walls was adopted. In harmony herewith, the end faces of the transverse walls were treated in the manner shown in Fig. 2. The top of each wall is crowned with a simple capital upon which rests the sidewalk bracket. Just behind the ornamental face of the walls is a battered buttress which adds to the appearance of the wall and emphasizes its stability. The battered buttresses curve into a band of concrete 18 in. thick and of varying height, resting upon the extrados of the arch.

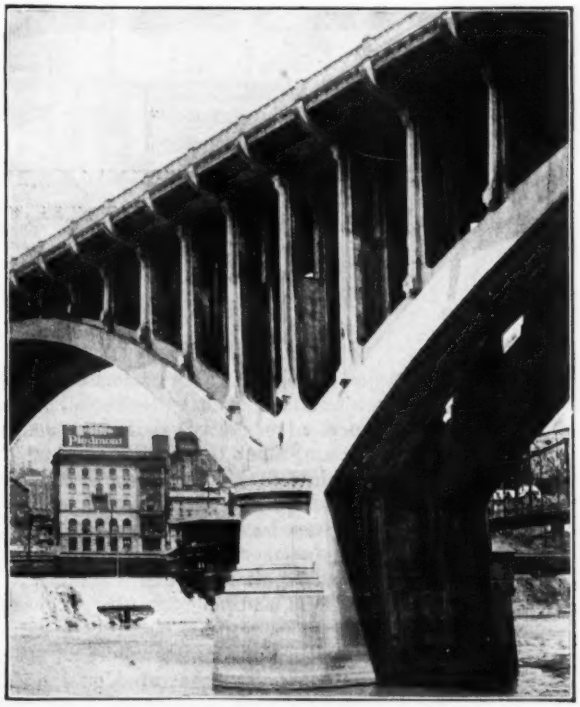


FIG. 2. ARCHITECTURAL DEVELOPMENT OF PIER AND WALLS

This band or fin has no structural significance and serves merely as an architectural device to tie in the bases of spandrel walls and give a feeling of greater stability.

Architecturally, the abutment towers are appropriately monolithic in appearance and flank the series of arches, separating in a most effective manner the long arch spans from the shorter horizontal spans of the approaches on either side. Fig. 6 shows the architectural treatment of the upper part of the abutment; a 50-ft. flag pole with bronze base crowns the kiosk covering the interior stairway. Note the delicate treatment of the vertical surface below the circular balconies. By cutting up the surface into small shallow square panels, the difficulty of obtaining a high plane surface of uniform texture and color was obviated, and at the same time the monotony of plain surfaces was avoided.

Special attention is called to the design of the combination lamp and trolley poles (Fig. 5). The arrangement of two lights one above the other is an interesting solution of the bridge lighting problem. Practically no light is wasted on the river below. Each of the two globes shown contains a 200-watt nitrogen lamp on circuits so arranged that the illumination of the roadway of the bridge may be varied from a maximum brilliance with all lights burning, to the all-night illumination with only the lower lamps on alternate poles in use.

Construction Features—Simultaneous construction of the three large arch spans, use of wooden forms, and cableway transport of material from bank to bridge were the defining features of the execution of the work.

Bids were received in December, 1917, but it was not until May, 1918, that the commissioners closed a contract with the John F. Casey Co., of Pittsburgh, to erect the bridge at cost plus a fixed compensation of

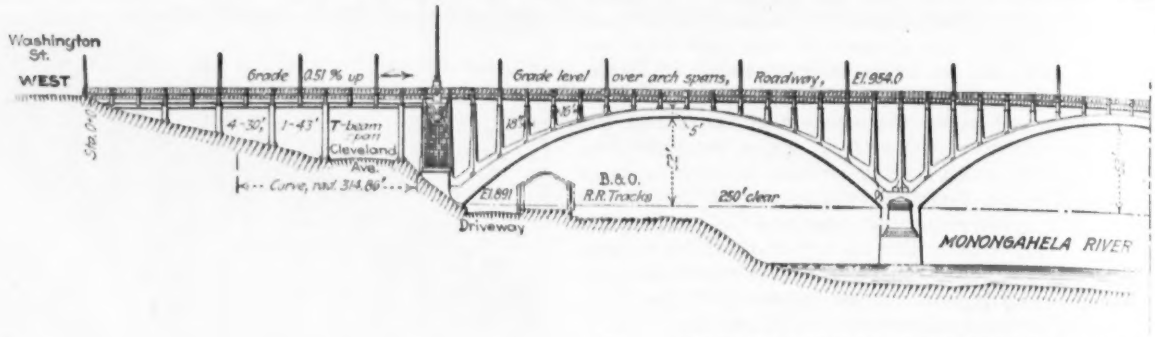


FIG. 3. PROFILE OF BRIDGE CONTROLLED BY CHANNEL.

$40,000, about 9 per cent of the then estimated cost of construction. Work was not begun until the fall of that year, except in a preliminary way, as it was desired to utilize the lumber and plant then being used on the South Side bridge (described in *Engineering News-Record* Aug. 7, 1919, p. 270). Before completion of the latter the city purchased a twin cableway of 1,254 ft. span (138½-ft. steel towers), and this became the central item of the construction plant.

In the winter of 1918-19, equipment having a capacity of 500 cu.yd. of concrete per 10-hr. day was installed. On account of lack of space on the west side, all operations of the contractor were concentrated on the east side. Several schemes for plant layout and units were considered and the economics of various arrangements of machinery and of renting as against purchase by the city were studied. It was decided to rent the mixer and electric hoist and derrick which made up the machinery of the mixing plant. Saw mill and blacksmith shop equipment were bought by the city, as were also line hoppers, chutes, material derrick and all major and minor tools. Other rental units were derrick boat, centrifugal pumps, pile driver and steam hammer, concrete buckets, skips and excavation dump buckets.

Arrangement of Plant—At right angles to the west abutment pier and about 150 ft. from the cableways, which were erected so that the cable distributed on the centerlines of the main arch ribs (28 ft. apart), was located a 2-yd. mixer, about 20 ft. below the railroad tracks and set out far enough from the edge of the embankment to permit of a special siding serving the plant. Above the mixer was built a sand-and-gravel bin, with capacity of 200 tons of sand and 200 tons of gravel. Just to the south, storage bins of 3,000 tons capacity were built on the slope of the railroad embankment, with rough pile and board sides and floors. Dump holes under the track allowed all sand and gravel, which was delivered in bottom-dump coal cars, to flow into the bins. The mixer hoppers were served and kept full as needed from the storage piles by a 2-yd. clamshell bucket operated by derrick, which also assisted in unloading and piling sand and gravel. To the north, but directly built onto the mixer feeding platform, parallel to the siding, was constructed the cement shed, with a capacity for 4,000 barrels of cement. This arrangement allowed

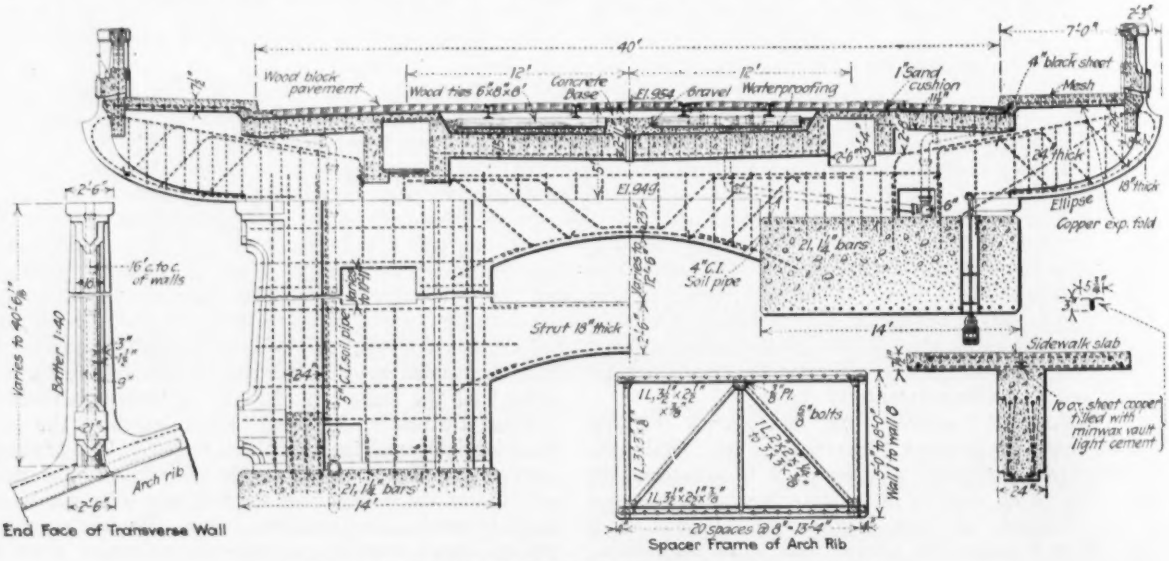
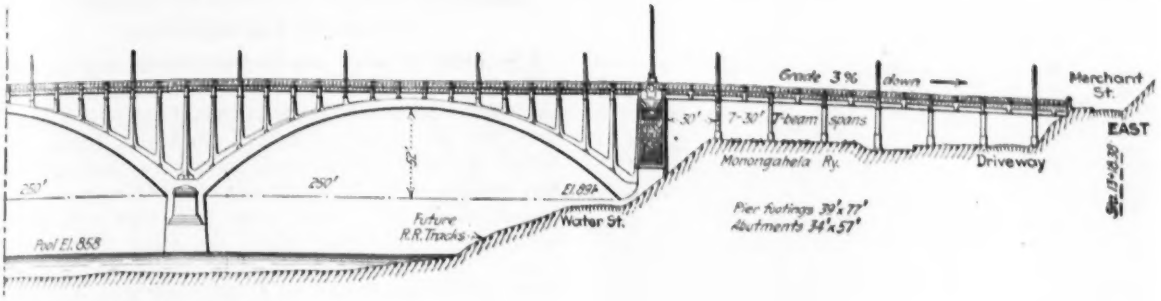


FIG. 4. WALL AND DECK CONSTRUCTION IN MAIN SPANS

using cement from car to mixer in some instances, but on long runs there was not sufficient siding capacity, and so storage was necessary. Storage was a necessity also because of uncertain deliveries due to war conditions.

From the mixer mouth to the cableways was constructed a track on a level low enough to allow 3½-yd. buckets on a four-wheel flat car to be pulled in under the discharge hopper of the mixer. A 25-hp. electric hoist operated this car with an endless line back and forth from the mixer to cableway. This plant mixed



CLEARANCE REQUIREMENT

and distributed into place over 600 cu.yd. of concrete in one continuous run.

The cableways, which were of 7-ton capacity, transported concrete chiefly, but also handled over 1,000 M ft. of lumber. They were operated with the aid of signal men and electric bells, as most of the time the operating enginemen, located on the east end, were unable to see where their loads were to be landed or picked.

After centering construction was started, an air compressor was installed on a rental basis, to supply air for three woodboring machines, which earned their cost over and over again in the drilling of holes for the thousands of bolts used in the centering. Further use of this unit was made in the rock excavation operations, drilling concrete, etc.

River pier construction was carried out in 1919. Cofferdams of steel sheetpiling driven to get a bite into the rock, bermed up outside with clay and boulders, and thoroughly braced, were used at both piers. Abutments and approaches also were completed in that season. The arch ribs and most of the floor were constructed in 1920, running on into the spring of 1921, after which finishing, waterproofing and roadway work were done.

Centering—The three spans were centered simultaneously, and no center was struck until completion of the ribs of all spans. The centering of the spans differed, however, because of local conditions. That of the easterly span consisted of posts, braces, caps, joists and flooring, founded on river bottom on pile bents of six and nine piles, capped and braced. In the westerly span railroad tracks and freight sheds had to be spanned by structural steel posts and beams, on top of which timber centers carried the rib loads.

The middle-span centering was designed to take care of a 60-ft. channel. There being no cover to the rock bottom under this span, and flood and drift risk being present, the posts of the centering were set on individual concrete piers, 2 x 4 ft., placed in the river by a cofferdam. Eight cofferdams were constructed, each holding six pedestal piers. For each rib the timber framework from the springing line up was arranged in umbrella shape and its loads were carried through hardwood caps and wedges down three 12 x 12-in. timbers to each concrete pier.

In all the centering, long timbers were used, which permitted longer spacing and less waste. All caps were 12 x 14 in. x 60-ft. fir. These pieces were later utilized to material advantage in the erection of the superstructure.

Concreting—One pair of ribs contains 1,800 cu.yd. The ribs of each span were poured in four operations, each requiring 10 to 12 hr. Each rib was divided into seven sections. The crown sections of the two ribs of a span were poured first, the four skewback sections the following, and on the next two days the sections adjoining the crown and the closing sections respectively, completing the span. Work started in the easterly span and progressed in order to the west span.

Considerable effort was necessary to have sufficient material on hand for the completion of one pair of ribs, which meant four days running. The Baltimore & Ohio R. R. in several instances assigned twenty cars at a time to sand and gravel supply; Ohio River material was used, coming from Wheeling. The Monongehela Ry. brought as many as ten carloads of cement in one shipment from the mill at Wampum, Penn.

The forms for the transverse walls were assembled of shop-built sections, heavily built for repeated use. Rapid progress was made on the walls, and as soon as they were well advanced work was begun on girders

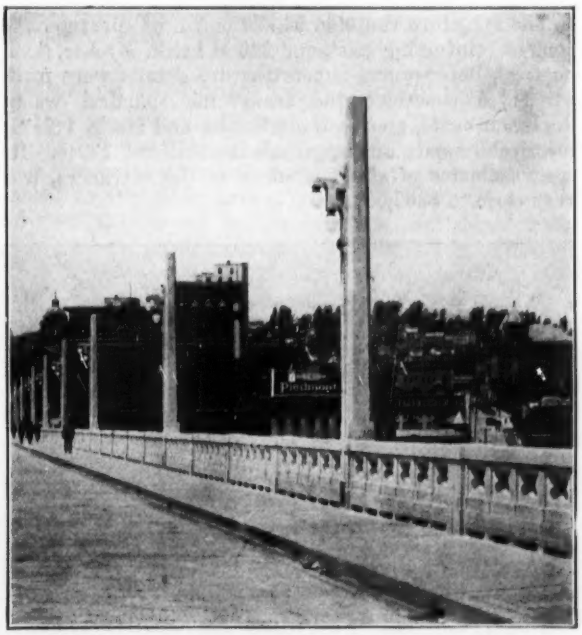


FIG. 5. DOUBLE-BRACKET CONCRETE LAMP POSTS

and brackets, following through with floor-slab and sidewalk construction.

Floor forms were built in sheets and lightly tacked on stringers supported on bents, resting on the long timbers removed from the centering and bolted to the sides of the walls. Bracket forms were also supported by these timbers, as were also parapet beams and side-

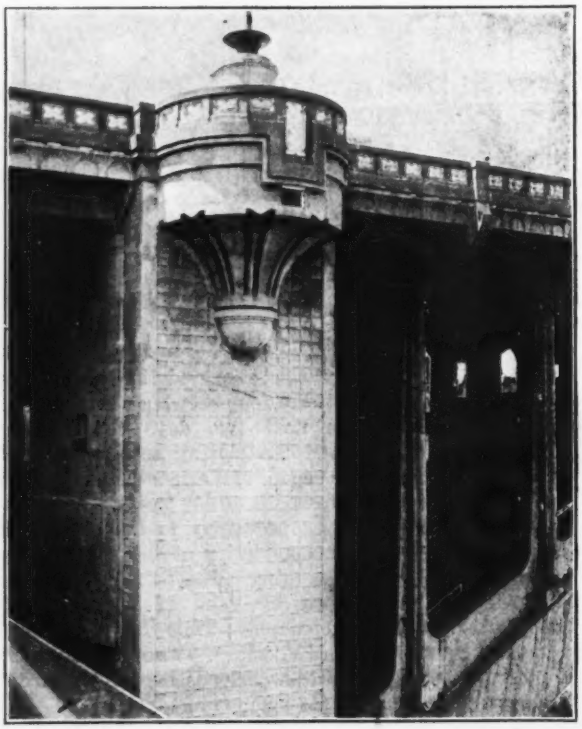


FIG. 6. CHECKERED SURFACE OF ABUTMENT FACE

walk forms. All concreting of the floor slabs was continuous between expansion joints.

The structure contains 24,880 cu.yd. of concrete, 770 tons of reinforcing steel, and 220 M brick. Arches, floor, copings, parapet and superstructure details were made of 1:2:4 concrete; the transverse spandrel walks, approach bents, approach abutments and track, 1:2½:5; piers, abutments and approach foundations, 1:3:6. Its cost, exclusive of street grading at the entrances, was very close to $860,000.

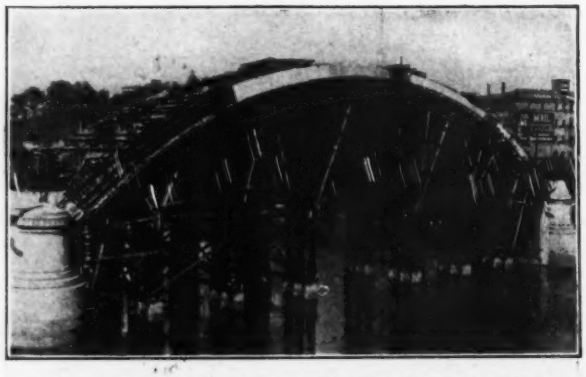
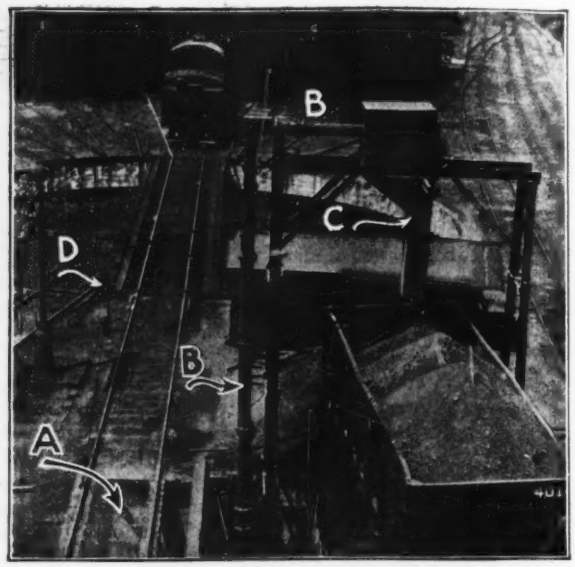


FIG. 7. CENTERING OF MIDDLE SPAN WITH 60-FT. NAVIGATION OPENING

The design was made by the Concrete-Steel Engineering Co., William Mueser, chief engineer, and Charles F. Bornefeld, resident engineer. Associated with the engineers was Major Henry Hornbostel of New York as consulting architect. Samuel L. Fuller was superintendent on the work for the contractor. Shrewsbury B. Miller is city engineer of Fairmont.

Railway Ashpit Cleaned by Steam Jets From the Locomotives

AN ASHPIT with ash-ejector system operated by steam from the locomotives is a novel feature in the engine terminal of the Akron, Canton & Youngstown Ry. at Britain, a suburb of Akron, Ohio. The ashpit is located in a track leading to the turntable and consists of a side discharge concrete hopper. In a trench along the bottom is an 8-in. pipe with a top opening or intake into which the ashes slide or are raked. One end of the pipe has an air inlet and the other end is connected to a tall riser pipe having a horizontal arm carried by a steel tower spanning a track for the ash cars. From the end of this arm a drop spout hangs over the track in a vertical position.



ASH REMOVAL BY STEAM JET

A—Side discharge ashpit. B—Ash pipe. C—Chute to ash car. D—Steam blower pipe to be attached to dome of engine.

When an engine is spotted over the pit or hopper, and while its fire is being drawn, a steam pipe is attached to the engine dome by a quick-acting screw connection. As soon as the grates are cleaned, steam is turned on and the ashes are blown through the pipe and discharged into the car. It was intended originally to have each engine blow its own ashes, but it is found that the pit is large enough to serve three engines before it is cleaned. As the hot ashes cannot be wetted in the pit, water is sprayed into the upper end of the conveyor pipe in order to quench them. With the engine in position it takes an average of ten minutes to pull the fire, five minutes to blow the ashes from the pit and two or three minutes to connect and disconnect the steam pipe. When the operation is finished, the engine still has steam enough to move into the roundhouse.

This ash handling plant was built by the Conveyor Co., Chicago, under the direction of S. S. Senter, chief engineer of the Akron, Canton & Youngstown Ry. A plant of the same type on the Denver & Rio Grande R.R., but with two ashpits served by steam from a stationary boiler, was described in *Engineering News-Record* of June 10, 1920, p. 1161.

Dirt Roads Treated with Steam Ashes and Cold Road Oil

By Fred. H. Shepheard and E. E. Butterfield
Office of the President of the Borough of Queens, New York City

STEAM ashes and cold asphaltic oil as a form of treatment for dirt roads in the Borough of Queens, New York City, were employed for the first time during the summer of 1920. The following specifications, representing a change from those previously used, were employed:

1. Specific gravity at 25°/25°C. (77°/77°F.), 0.930 to 0.975.
2. Specific viscosity at 50°C. not more than 30.
3. Loss at 163°C. (325°F.), 5 hours, not more than 30%. Float test of residue at 50°C., not less than 50 sec.
4. Total bitumen (soluble in CS_2), not less than 99.5%.
5. Per cent of total bitumen insoluble in 86° B. naphtha, not less than 6.0%.

Tests shall be made in accordance with the methods of Bulletin 691, U. S. Department of Agriculture.

It was observed that the oil purchased under the foregoing specifications tended to form a bituminous mat with the surface dirt of the road after the volatile portion of the oil had evaporated. In the fall of 1919 many of the dirt roads to which this oil had been applied were covered wholly or partially with a bituminous-dirt carpet varying from a fraction of an inch up to several inches in thickness. This was extremely important from a practical point of view. There are about 700 miles of dirt roads in the Borough of Queens and it is impossible to treat all of them with a dust-laying oil each year. If it were possible to form a more or less permanent bituminous mat upon the surface the dust nuisance would be removed and the mileage of roads requiring treatment with a dust palliative would be progressively reduced.

Heavy Oil Forms Mat

The use of light distillate, such as is usually recommended for dust palliation, offers little prospect of permanent reduction of the dust nuisance. Furthermore, the prices of such distillates put them out of reach of a community where, under the most favorable conditions and with low-priced materials, it is only possible to treat a fraction of the total mileage of dirt roads each year. It was, therefore, necessary to turn to the heavier oils which were not usually recommended as dust layers on account of their slow volatility and their tendency to leave sticky residues on the road. If the residue, however, has binding properties and will form a mat with the surface dust and dirt that property which was formerly regarded as a detriment may be turned into an advantage. The oil which was delivered in 1919 appeared to possess this valuable property and we were encouraged to go a step further.

The surface of a dirt road is usually irregular and rutted and in such cases the uniform application of oil will not insure the formation of a protective mat even if the oil has the necessary binding properties. Furthermore, the surface dirt and dust, besides its variable nature in different localities, is not a desirable or suitable material for the mineral constituent of a bituminous mat.

If the surface of the road could be evened up, covered with inert mineral matter and followed by the application of oil, the resulting mat should be more stable and insure a better exclusion of the dirt and dust from the road surface. Sand, gravel, grits, chips, could not properly be used without changing designation of the type of road and are furthermore excluded on the score of present prices.

Steam ashes were selected as the cheapest available material, possessing also the advantage of porosity. This porosity should enable the ashes to absorb a considerable quantity of oil, rendering the road dustless and at the same time not unduly wet and sticky. Ashes were purchased under specifications calling for clean ashes showing loss on ignition less than 35 per cent.

Contrary to expectations it appeared that black ashes with a high percentage of combustible matter are best suited for building up a durable surface with cold road oil. Ashes containing as much as 44 per cent of combustible matter have given excellent results. Thoroughly burned gray ash, with low combustible matter, breaks up into powder and dust and does not form a stable mat.

The method of treatment was as follows: The dirt road was honed and shaped with a road machine and all foreign materials removed. Upon the road was spread from 4 to 6 in. of ashes. The spreading of the ashes was done preferably by hand although it could have been done by road machines. After the spreading, the road was opened for a few days to allow traffic to work the ashes in. During this period the ruts were raked full and the road kept to its proper shape. The oil was then applied at the rate of ¼ to ½ gal. per square yard. To finish the road like a sheet-asphalt pavement all that is necessary is to roll the surface with a road roller of at least 5 tons. Only one application of oil has been used this season with the ash treatment. The cost of labor and materials averages not more than 27c. per square yard.

Great Britain Shows 4.7% Population Gain

THE population of Great Britain (England, Wales and Scotland) on June 19 was 42,767,530 according to a preliminary announcement of the census count cabled to the New York *Times*. This is an increase of 1,936,134, or 4.7 per cent in the past decade, the smallest rate of increase in the past hundred years. It is stated that the increase would have been still less had not emigration been checked by the war. The excess of females over males in Great Britain increased greatly during the past decade, the excess for 1911 having been nearly 1,200,000 against more than 1,900,000 in 1921. The ratio of females to males in 1921 was 1,095 to 1,000, the highest ever recorded.

The administrative county of London, including the cities of London and Westminster, and some twenty-five boroughs, had a population of 4,483,241 this year, a decrease of 0.9 per cent from 1911, but the metropolitan police area showed a gain of 3.1 per cent, the total population figure for 1921 being 7,476,168.

British islands adjacent to Great Britain, but not including Ireland, for which no census was taken this year, showed a population of 299,704 this year.

Populations for other parts of the British Empire outside of those named and Canada are reported as follows: Indian Empire, 319,075,132, an increase of 1.2 per cent; Union of South Africa (Europeans only), 1,521,635, or 19.2 per cent increase; Australia (excluding full-blooded aborigines), 5,426,008, an increase of 21.8 per cent; New Zealand (excluding the Maoris), 1,218,270, an increase of 20.8 per cent.

Liberty Tunnels Driven by Full-Section Excavation

Double-Tube Highway Tunnel at Pittsburgh Advanced 250 Feet per Month by Alternate Drilling and Mucking Shifts—Steam-Shovel Mucking—Lining Placed Inside Lagged Steel Arch-Set Timbering

DRIVING a two-roadway street through the South Hills at Pittsburgh to bring outlying residential districts into close connection with the downtown section of the city, the contractors, Booth & Flinn, are making systematic and rapid progress by full-section face work and steam-shovel mucking. The tunnel comprises two separate tubes each about 26½ ft. wide, spaced 59 ft. apart center to center, and is to be 5715 ft. long between portals (See *Engineering News-Record*, July 8, 1920, p. 52). The nature of the rock through

FIG. 1. SHOVEL MUCKING FULL-SECTION FACE

which the tunnel penetrates controlled the construction methods both in general plan and in detail. The material, a horizontally bedded and slightly fissured shale carrying practically no water, weathers rapidly, but for a month or more after opening up is not subject to slides or falls and puts little weight on the lagging. Because of these conditions a simple arched roof timbering is used, and the excavation is made to full section right at the working face, permitting the lining to be kept close up to the heading, usually within 100 to 150 ft. The face is actually drilled and shot in two sections, the upper or arch heading and a very short bench, just long enough to give room for drilling; all the face muck is taken out by steam shovel.

A rate of progress of 10 ft. per day, or 250 to 260 ft. per month for each tube, has been reached and maintained under this system. The work has up to recently proceeded down hill from the higher (south) end only, with no trouble whatever from water; recently the north approach has been cleared also and headings started there, though this work is under the disadvantage of a three-mile haul of the muck by motor trucks over bad grades to the disposal point, as there is no opportunity for disposal along the Monongahela River bank.

Order of Operations—Two shifts, day and night, are used regularly, making only one round, however. The night heading-shift drills, blasts and clears the corners of the heading for setting the wall plates; simultaneously a separate gang is engaged in concreting the lining. The day shift sets the wall plates and the timbering with its lagging, puts in the rock packing back of the lagging, and muck out the heading (by hand) while the shovel working on the floor clears out both heading and bench muck. The day lining shift moves and sets the concrete forms. This arrangement divides the haulage service, the tracks being used for concrete at night and for muck hauling in the daytime.

Payment for excavation and timbering is made by a bonus system. The lining and timbering gangs are paid 11 hr. for a 9-ft. advance and 12 hr. for a 10-ft. advance, regardless of the time required. The adoption of this system, after the beginning of the work, produced a marked advance in the speed and regularity of the work.

Face Work—A top heading is carried the full width of the tunnel, or about 32x15 ft. Smaller drifts were used only at the entrance. The bench face is kept about 10 ft. back of the heading face. The heading muck is largely thrown over the bench in blasting, so that hand mucking is minimized.

Small one-man drills are used, six machines to the heading and four to the bench, drilling respectively 20 to 30 holes and 16 holes. In the heading, the cut holes, four on a side, 8 ft. apart, are drilled 12 ft.

FIG. 2. SHORT BENCH BACK OF HEADING FACE

deep and the side holes 11 ft. deep, pulling 10 ft. The bench is generally drilled in two rows of 6 vertical holes 5 ft. apart, drilled 12 ft. deep, and four lifters. Drilling takes about five hours, usually. The drills being dry, the heading is quite dusty when the machines are going, but no ventilation has been found necessary except that given by the exhaust from the drills and the shovel. For blasting, a 40 per cent powder is used, 2½ to 3½ lb. per hole in the heading and 6 lb. per hole in the bench; the total consumption averages 1 lb. per cu.yd. The mucking shovel is a 1½ yd. machine operated by air. It loads into 4 yd. dump cars running on 36-in. track, and hauled in five-car trains by electric mine locomotive. Outside the tunnel the muck has

to be hauled about a mile to the dump in a public park, the track being on a 6 or 7 per cent upgrade. For this service steam locomotives are used. The total muck haulage amounts to about 200 cars per day.

Timbering—The arch timbering shown in the views Fig. 1 to 3 has proved very satisfactory from the standpoint of quick erection and resistance to injury by the blasting. It is also convenient in case local pressure on the roof produces distortion or in case yielding of the timbering makes it necessary to set emergency posts. Small sections of I-beam are then quickly bolted to the rings and the extra posts placed against these.

The regular ring consists of seven segments of 8-in. 32½-lb. H-beam, the segments being 6 to 6½ ft. long, terminating in a square skewback face fitted with a 15-in. foot plate. They are set generally at 4 ft. and 5 ft. alternate spacing, for a 9-ft. advance, or on straight 5 ft. spacing for 10-ft. daily advance. They are spaced by two ¾-in. tie rods and two 3x6 blocking pieces per segment, the blocking pieces being wired to the tie rods as a precaution against displacement by blasting. Yellow pine lagging 3 in. thick is laid over the rings in lengths corresponding to one ring space. Back of the lagging solid blocking is placed behind the joints between ring sections, and the remainder of the over breakage space is packed with rock. The amount of this packing is about 1.75 cu.yd. per lin.ft., or 11 per cent overbreakage. This packing is grouted, for strength and as a means of waterproofing the tunnel,

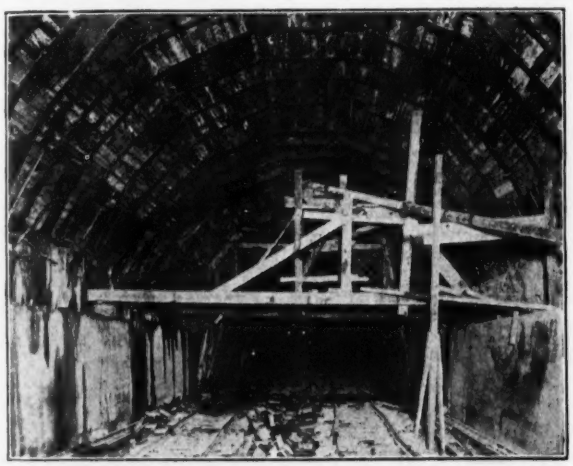


FIG. 3. SIDE WALLS AND ARCH CONCRETING

Blower filling collapsible steel form—Roof lagging placed on bottom flanges of beams to receive waterproofing.

when the lining is four to six months old. For this purpose 1½-in. grout pipes are set every 15 ft., one in the crown and one in each haunch; when forms are set, the grout pipes are extended through them by pieces of 2-in. pipe slipped over them.

A 12 x 12 in. wall plate is set as a foundation for the rings, in lengths equal to the daily advance (9 or 10 ft.). The timber is notched to receive the foot plates of the rings. Where the rock is of such character as to require posting of the wall plates, the posts are set after the bench is excavated. The posts, 12x12 timbers, average about 4 ft. long, rarely extending down to the invert, and are placed at and between rings.

In placing the timbering, the material is handled into the headings by a winch attached to the side of the shovel, with ropes working on a snatch block attached to the leading ring of timbering. Ordinarily it takes from 7 to 10:30 o'clock to set, lag and pack the first ring. Some little trimming is usually necessary before the second ring can be placed, but by 2:30 this ring also is completed and packed, after which the heading men muck out, ready for the night shift to start drilling.

Originally the bench excavation was carried down only low enough to receive the roadway surface, and trenches were cut later for the sidewall footings. The cost of this trenching led the contractor's superinten-

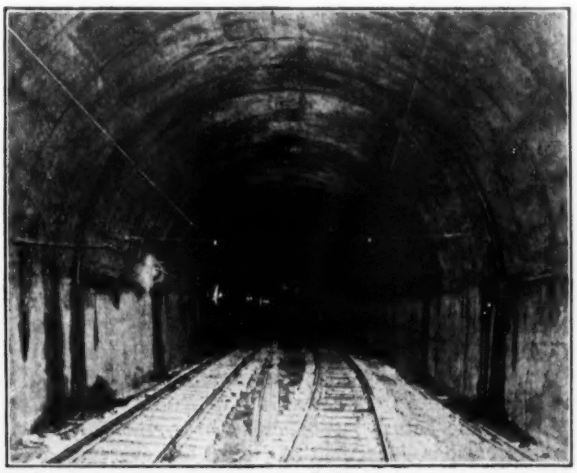


FIG. 4. COMPLETED LINING BEFORE GROUTING

dent to try excavating the whole width down to footing level, the extra depth of about 2 ft. to be backfilled with tunnel muck when ready for subgrading. This plan of working proved much cheaper than the former and involved less delay in preparing for concreting, and has therefore been regularly followed since.

Concreting—The lining operations are carried on in three stages, the footings, sidewalls and arch being concreted separately. For the footings, wooden forms are built in place, while collapsible steel forms are used for both sidewalls and arch. The arch concrete is blown into the forms by a pneumatic mixer in the tunnel, fed with premixed concrete brought in from a stationary mixing plant outside. Large yardages have been made and little delay or difficulty has developed in the concreting except during a short period when organic matter and loam in the sand interfered with proper setting. Since that time every car of aggregate is tested for organic matter and loam, and at intervals the grading is tested.

Footings are concreted to within 100 ft. of the heading (this distance being required for moving the shovel), sidewalls to a point 35 ft. farther back and the arch 50 to 75 ft. back of the sidewalls.

The sidewall form is the center of operations. It is a gantry-like structure comprising the forms for the two opposite walls and a wooden platform just above the foot of the arch, and trails back of it an inclined track about 80 ft. long, up which the concrete trains reach the platform. Under the platform is hung the pneumatic blower, which is charged directly from the cars overhead, and from which a 6-in. pipe leads back to the arch form. A tee on the end of the pipe inside this form distributes the concrete to the two sides. A pressure of 80 lb. is used for this blowing.

For the footing work, concrete is chuted from the platform deck, where it is shoveled into the chutes. The sidewall forms are filled by shoveling direct. As the concrete is mixed as dry as workable (slump, 4 to 4½ in.), it is spaded in the forms.

In preparing the arch form for concreting, the wooden spacer pieces are removed from between the steel rings, but the tie-rods are left in place and the arch reinforcement is wired to them. Holes are bored through the lagging so that in the subsequent grouting spaces between lagging and the concrete will be filled.

The sidewall form is 35 ft. long; the arch form, originally 25 ft. long, was subsequently extended by 5 ft. At the beginning of concreting, last December, when a length of about 1000 ft. of each tunnel was to be concreted as rapidly as possible before continuing the excavation, wooden forms were used to supplement the steel forms, but in the subsequent regular sequence of operations these wooden forms are not used.

Forms are stripped after 18 hr., and concreting is done every second or third day, to keep pace with the heading advance. Arch concrete is placed at the rate of six 4-car trains per hour, amounting to 16 cu.yd., which gives a rate of 160 cu.yd. per 10 hr. shift. This represents a trifle more than the volume of concrete (153 cu.yd.) in a 20-ft. length of tunnel (one tube). In an emergency period, however, over 1700 cu. yd. of arch concrete were blown in a week in a single tube.

From the actual inspection records, the full-section excavation per lineal foot of tunnel has averaged about 31½ cu. yd., against 23.7 theoretical, an excess of 34 per cent. The concrete placed has been 7.63 cu.yd., against theoretical 5.56, an excess of 37 per cent, most of the latter being in the arch.

According to J. C. Scott, resident engineer for A. D. Neeld, chief engineer in charge for Allegheny County, the productive labor cost in the work divides about 20 per cent to plant maintenance and operations, 53 per cent to excavation and disposal (29 per cent heading excavation, 7 per cent bench excavation, 17 per cent muck loading, transporting and dumping), and 27 per cent to concrete lining work.

For the contractors, the work is under the supervision of M. L. Quinn, general superintendent, R. F. Lee, field superintendent, and J. B. Sweeney, engineer.

Italian Harbor Work Under Way

The Italian Ministry of Public Works has approved the plans for improvement of the port of Leghorn, prepared by the Leghorn Harbor Works Board in accordance with the governmental project of December, 1916. The expenditure of 70,000,000 lire ($13,510,000 at normal exchange) in construction and equipment is contemplated, of which 37,000,000 lire is for a new harbor basin, 8,000,000 lire for railway terminals, and 25,000,000 lire for mechanical equipment, warehouses, etc. The harbor facilities of Leghorn will be more than doubled by the carrying out of this plan, which is expected to take 10 years for completion. An interesting feature is the opening of an outlet on the sea for the important town of Pisa, 10 miles from Leghorn. Work has already begun on the interior waterway.

The Italian Treasury was authorized by Royal Decree of January 29, 1921, to set aside 8,000,000 lire for use of the Leghorn Harbor Works Board. The board is stated to have been able to arrange for raising the additional funds required. American firms interested in the possibility of furnishing machinery and supplies to the contractors should write to the following address: "Il Presidente, Ente Portuale di Livorno, Livorno, Italy."—Consul Lucien Memminger, Leghorn, in *Commerce Reports*.

High Rainfall and Run-Off From Small Areas

By Ivan E. Houk
Assistant Engineer, Miami Conservancy District, Dayton, Ohio

A RAINFALL of unusual intensity fell on the drainage area of Honey Creek, above New Carlisle, Ohio, during the afternoon, 2 to 5 p.m. of July 29, 1918, causing flood levels in the upper sections of Honey Creek somewhat higher than during the great flood of March, 1913. Subsequent field and office investigations led to the following conclusions: (1) The maximum rainfall intensity exceeded 6 in. in three hours. (2) The depth of rainfall exceeded 2 in. in three hours over an area of 15 sq. miles. (3) The maximum rate of run-off amounted to 2,200 sec.-ft. per square mile from an area of about 6.7 sq. miles. Since recent search for data on maximum rates of rainfall and run-off from cloudbursts on small rural areas indicated that the records available were comparatively meager, the following is submitted:

The rain was unusually heavy over a narrow strip of land 5 miles long and 3 miles wide, running north and south directly over the drainage basins of the East and West forks of Honey Creek, the heavier precipitation being over the East Fork. The maximum stage on the East Fork a-mile above the junction of the two streams was 28 in. higher than in March, 1913. A farmer living within ¼ mile of this place measured 6 in. of rain in a paint bucket, larger at the bottom than at the top and located about 50 ft. from any obstruction. The bucket was said to have been empty when the rain began. The total precipitation at New Carlisle, the nearest rain gaging station, about 2 miles distant, amounted to only 1.74 in., the whole amount falling within a period of two hours. No other rainfall measurements were made. However, the descriptions of the residents, as well as the flood marks on the ground, indicate that the total exceeded 2 in. in three hours over an area of about 15 sq. miles. The accounts of the storm also indicate that during short periods of time the rate of rainfall was much higher than the average, as naturally would be expected. The ground was fairly wet when the rain began due to a precipitation of 0.62 in. which had fallen during the preceding evening.

The areas drained by the two forks of Honey Creek are made up of the gently rolling topography so common in the older glaciated regions. Practically all of the land is cultivated, not over 2 per cent being in timber. Ground slopes vary from 40 to 100 ft. per mile through the fields and from 20 to 40 ft. per mile along the streams. The surface soil is a glacial till containing some sand and some gravel, but it is not unusually pervious.

Careful hydrographic surveys were made immediately after the flood, before any of the high water marks became obliterated. Flooded cross sections and water surface slopes were measured at the upper, as well as the lower ends of the strip of land on which the heavy rain fell, so that estimates of the maximum rates of run-off could be made for the proper areas. Drainage areas were determined from the U. S. Geological Survey topographic quadrangles. Calculations by Kutter's formula, using values of n of from 0.040 to 0.060 according to local roughness conditions, gave the following results:

Stream	Drainage Area in Sq.Mi.	Total Discharge Sec.-Ft.	Rate of Run-Off in Sec.Ft. per Sq.Mi.	In. per Hour
East Fork of Honey Creek	5 1	350	70	0 11
East Fork of Honey Creek	11 8	15,200	1,290	2 00
East Fork of Honey Creek	6 7	14,850	2,210	3 43
West Fork of Honey Creek	21 5	3,810	177	0 27
West Fork of Honey Creek	18 0	300	17	0 03
West Fork of Honey Creek	3 5	3,510	1,000	1 55

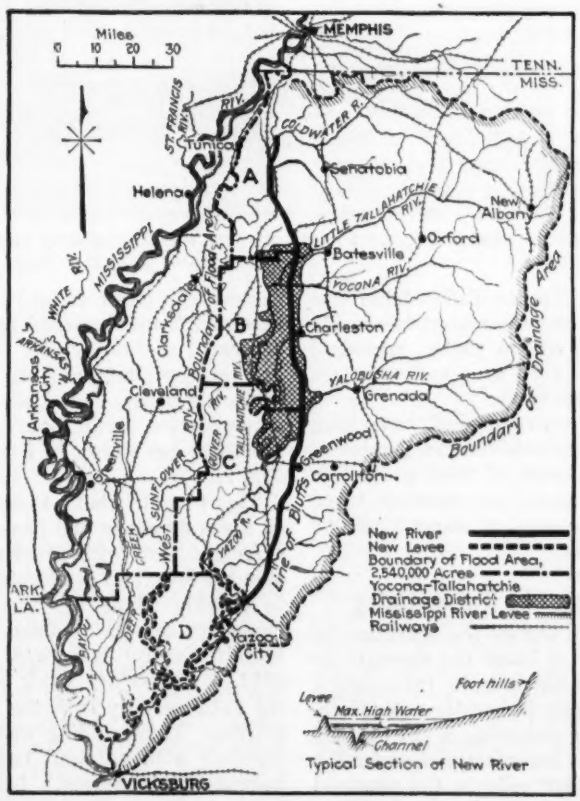
While the above data are somewhat uncertain they are not believed to be greatly in error. Cross sections and surface slopes were accurately determined, so that the only chance for error lies in the application of the Kutter formula. The calculated velocities varied from 2.5 to 7.3 ft. per sec., which do not seem unreasonably high for flood conditions in streams having such steep slopes.

A New River Planned for Flood Protection and Drainage

In Largest Drainage Project for 4,000 Square Miles Along Mississippi a 140-Mile Channel to Carry Off Hill Waters

A FLOODWAY channel or new river 140 miles in length is the striking feature of a project for the flood protection and land drainage of about 4,000 square miles in what is known as the Yazoo delta, in Mississippi. This is considered to be by far the largest area ever included in one drainage project.

The Yazoo delta is an oval area of about 7,000 square miles of alluvial land extending from near Memphis, Tenn., to Vicksburg, Miss., about 200 miles, and having a maximum width of about 60 miles. Its western boundary is the Mississippi River, and its eastern boundary is a line of foothills. As shown by the accompanying map, the Coldwater River enters near the north end and after about 40 miles joins the Little Tallahatchie River to form the Big Tallahatchie; the latter in turn joins the Yalobusha River about 40 miles further south, near Greenwood, to form the Yazoo River. A winding channel through the eastern part of the district and 4 to 10 miles from the foothills is formed by the Coldwater, Big Tallahatchie and Yazoo rivers, but south of Yazoo City this last river keeps more closely to the foothills until it enters the Mississippi River just above Vicksburg.



FLOOD PROTECTION AND DRAINAGE FOR YAZOO DELTA

Existing levees along the west side of the delta protect it from the Mississippi River, but as these stop about 20 miles above Vicksburg, the lower portion of the area is subject to overflow by backwater. With the river thus shut off, all the internal drainage is received by the Yazoo River, which has a drainage area of some 14,200 square miles, half of this being in the delta and half in the hill lands to the east. These hill lands, subject to frequent and heavy rainfall, have a sharp slope, giving a rapid runoff to the streams. Although the delta has numerous water courses they are inadequate to carry the combined runoff, so that both flood protection and improved drainage are needed for about 4,000 square miles in the eastern and southern portions. Much of this area is already under cultivation.

The western portion, about 3,000 square miles, is protected against floods by the Mississippi River levee and by a divide east of the Sunflower River. Adequate natural drainage for this part of the delta is provided by the Sunflower River and other streams, all of which drain eventually into the Yazoo River.

The necessity of co-operation in a project of such magnitude is illustrated by the earlier developments in the delta. In 1908, a drainage district of 2,340 square miles was organized in the northern part, but owing to opposition by some landowners the comprehensive plans were abandoned and in 1911 the district was dissolved. Since then a number of small districts have built ditches and levees and have straightened some of the hill streams, with the result of causing heavier and more frequent floods outside these local districts. In fact, it is stated that many tracts which were formerly cultivated with success are now unprofitable by reason of too frequent flooding.

Owing to this increase in floods, landowners near the confluence of the Coldwater, Little Tallahatchie and Yalobusha rivers organized the Yocona Tallahatchie district in 1917 and engaged engineers to investigate the necessary protection and drainage works. It was soon found that such works would have to extend far beyond the legal boundaries of the organized district. When the situation was explained to the landowners, they directed the engineers to consider the broader problem of flood control for the entire northern part of the delta, as far as Greenwood, Miss.

From these studies was developed the New River project for carrying off all the hill storm waters in a floodway formed for a distance of 140 miles. The north end would intercept the Coldwater River and the south end would discharge into the Yazoo about five miles above Yazoo City. From the latter point levees would be built along both sides of

the Yazoo River and its main tributaries. The Mississippi levee would also be extended south to connect with the Yazoo levee and thus protect the southern part of the district from both headwater and backwater floods. The floodway would be from ½ mile to 1½ miles wide, with a levee averaging 17 ft. in height.

Gates in the levee would be open normally to permit the runoff to pass into the natural channels through the delta and maintain the necessary supply for cultivation. At flood times, these gates would be closed, and all flood waters from the hills confined to the floodway, the internal runoff of the delta lands being carried by the water courses and ditches. A low water channel in the floodway would drain the enclosed land after flooding. Silt basins and lateral levees would be provided at the entrance of hill streams into the floodway.

About 60 per cent of the area of the delta, or 2,540,000 acres in the eastern and southern portions, is subject to overflow and subsequent delayed drainage, as noted above. This portion divides logically into the four sections indicated on the map; A, Coldwater section, 310,000 acres; B, Tallahatchie section, 480,000 acres; C, Yalobusha section, 850,000 acres; D, Brunswick section, 900,000 acres. It is expected that the work will be carried out by three or four drainage districts, organized separately, but co-operating in a general plan. The Yocona-Tallahatchie district, shown by the shaded area on the map, is already organized. This district and others partly organized include more than half of the flood area and steps are being taken to co-ordinate their work.

Investigations for this extensive project have been carried on since 1918 by the Elliott-Harman Engineering Co., Peoria, Ill. The expense of flood protection is estimated at about $15 per acre, this estimate being based on studies made for the area of about 1,000,000 acres north of Greenwood, Miss.

Lumber Value Not Affected by Turpentining

Contrary to usually accepted theory the operation of turpentining pine trees does not lower the strength or resin content of the wood, according to information obtained by the Forest Products Laboratory, Madison, Wis. The crude turpentine, or oleoresin, is not drained from a store in the tree, but is manufactured under the stimulus of the wound by living cells in the sapwood immediately adjacent to the cut on the trunk. The major part of the tree is not appreciably affected, and the loss due to death of trees or to a reduction or degrading of lumber is very small when the proper method of turpentining is followed. This loss is more than offset by the additional revenue obtained through turpentining. The greater part of the wood that is chipped away would not have become finished lumber, but would have gone into slabs and edgings at the sawmill.

Small Station Layout Illustrated in New Structures

Illinois Central R.R. Depot and Freighthouse Good Examples of Building and Trackwork at Smaller Cities

A RECENT example of improvements to railway station layouts in cities of the smaller class is afforded by the entire reconstruction and rearrangement of the passenger and local freight facilities of the Illinois Central R.R. at Centralia, Ill., this work having become

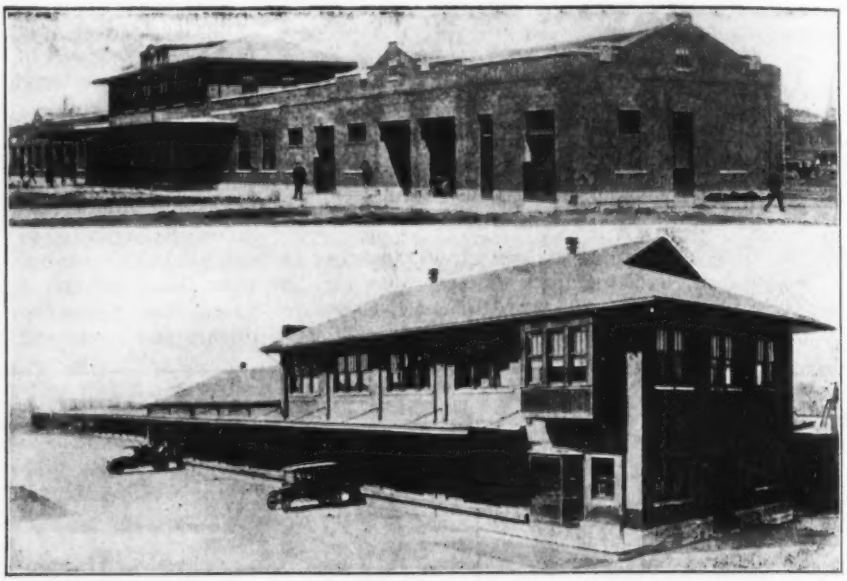


FIG. 1. STATION (ABOVE) AND FREIGHTHOUSE (BELOW) AT CENTRALIA; ILLINOIS CENTRAL R.R.

desirable in order to accommodate the increasing business and being hastened by the destruction of the old passenger station by fire. Instead of simply erecting a new station building, the opportunity was taken to revise the whole layout at a cost of about $400,000 for a new station, freighthouse, tracks and approaches. The buildings are shown in Fig. 1, and the general plan in Fig. 2.

This town of about 13,000 population is the terminal of three divisions and has a large engine terminal and a freight yard with gravity switching, but as no division headquarters are located here it was only necessary to provide offices for the station staff. There is a passenger service of about 35 trains daily. When the Illinois Central R.R. was built through Centralia in 1853, a three-story brick station and hotel was built, the hotel serving both the public and the railway employees. This building was burned in February, 1918, together with adjacent two-story frame buildings for baggage and express. In removing the old freighthouse, built at about the same time as the station, it was found that it had white oak posts and framing, yellow poplar flooring, joists and rafters, white pine siding and yellow poplar sheeting 12 to 18 in. wide. All the framing was mortised and draw-pinned.

To increase the passenger facilities, the double track main line has been developed to give four tracks through the station, with two brick platforms 16 x 1,000 ft. and one 12 x 400 ft. The lighting is by elec-

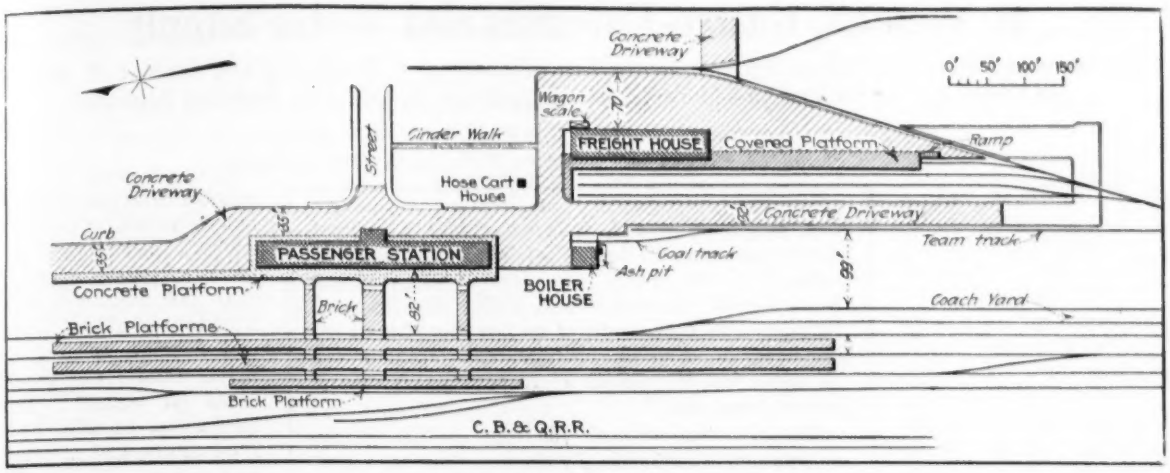


FIG. 2. LAYOUT OF NEW STATION AT CENTRALIA

tric lamps on tall poles, no platform shelters being built. A two-track coach yard for passenger cars that lay over at night is provided with water and steam heat connections. For the local freight service there are three stub tracks at the freighthouse, team tracks, industry tracks and a branch to the boiler house of the station. Concrete driveways serve the passenger station and freighthouse and the surroundings will be made attractive by grass plots and shrubbery.

In the design of the passenger station, 314 x 37 ft., a feature of interest is its division into three parts separated by 23-ft. arcades but all under one roof, as shown in Fig. 3. The two-story central portion has the principal station facilities; ticket office, waiting and toilet rooms in the middle, with the baggage and express rooms at opposite ends. On the upper floor are the telegraph office, a conference room and offices for the assistant yardmaster, track supervisor, conductors, switchmen and special agent. The dining room and kitchen occupy one of the separate one-story end portions of the building, the other having an ice room and rooms for the linemen and car repairers. The freighthouse, 182 x 40½ ft., has for half its length an upper floor for offices and file room. Beyond the building is a covered platform 24 x 274 ft.

Between the two main buildings is a boiler house for the heating plant, coal for which is dumped into a combined track hopper and storage bin, the floor of which is level with the boiler room floor. Ashes are stored in an underground bin which is fitted with a vertical bucket conveyor discharging through an inclined spout either into a car or a wagon. A pipe tunnel in the station gives ready access to the steam and water pipes and electric conduits. For fire protection there are four outside hydrants and the freighthouse has water connections with hose attached.

A rough dark red brick is used for the exterior, with trimmings of Bedford limestone for the station and of precast concrete for the freighthouse. Timber trusses and trussed rafters carry slate roofing, except that the boiler house has a concrete roof. Buff pressed brick forms the interior of the waiting room, but otherwise the finish is mainly of wood in both buildings. Iron plate protection for the lower part of the exterior wall on the driveway side of the freighthouse is an unusual provision, the plating being ⅜ in. thick and 29 in. high. Large sliding doors are placed in both sides of the freighthouse.

The general building contract was let to Joseph E. Nelson & Sons, Chicago. Tracklaying and installation of electric equipment were done by railway forces. The buildings were designed by D. F. McLaughlin, architect for the railway, and the work was in charge of F. R. Judd, engineer of buildings. Both design and construction were under the direction of F. L. Thompson, chief engineer, Illinois Central R.R.

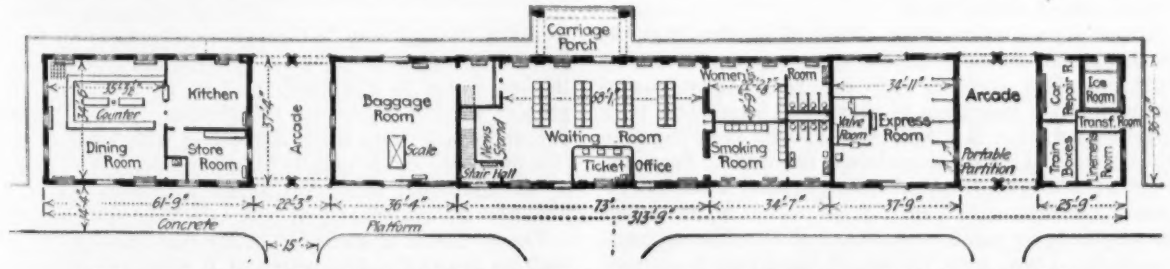


FIG. 3. PLAN OF PASSENGER STATION, SHOWING ARCADES SEPARATING IT INTO THREE PARTS

How Residences Follow Street Car Lines

In the four cities clustered together on the east side of San Francisco Bay, 3,353 residential building permits were issued during the 18 months ending June 30, 1921, and of these 85 per cent were within three blocks of street car lines. The estimated cost of this 85 per cent was $15,030,412 as against $1,433,355 for those not within three blocks of a car line.

B. Welchii, Gastro-Enteritis and Water Supply

Short Cuts to Purity—B. Enteritidis Sporogenes Test Abandoned in London—Case Against B. Welchii and Other Spores Not Proven—More Studies Suggested—B. Coli Test Remains Supreme

By Sir Alexander Houston, K.B.E., C.V.O., M.B. D.Sc.,
Director of Water Examinations, Metropolitan Water Board, London, England

A continuation and to some extent a critical review of the discussion of the same general subject by 66 water experts in "Engineering News-Record," June 2 and 9, 1921. The frequent references in those articles to Dr. Houston as an exponent of British practice and opinion led "Engineering News-Record" to secure this contribution from him.

Dr. Houston worked for the British Local Government Board on lead poisoning from moorland water and on other public health studies, 1893 to 1905; for the London County Council on sewage treatment experiments, 1898-1900; was bacteriologist to the Royal Commission on Sewage Disposal, 1899-1905; bacteriologist to the City of Lincoln, England, during the typhoid epidemic of 1905, and has filled his present position, noted above, since 1905. During the Lincoln epidemic Dr. Houston introduced chlorination of the water supply, which was continued until a new supply came into use in 1911. Besides various papers and reports, including a notable series of research reports on the contents and treatment of London water, he has published: "Studies in Water Supply" (1913); "Rivers as Sources of Water Supply" (1917); and "Rural Water Supplies and Their Purification" (1918)—Editor.

I PROPOSE to make a few comparisons between "slow" and "rapid" filters, touch on the views of "chlorinators" and "anti-chlorinators"; point out the divergent claims made as regards the identity of B. Welchii. etc.; deal with the evidence implicating the spores of anaerobes generally; suggest that comparative bacteriological and epidemiological investigations should be carried out in the United States and Canada; consider the evidence of American sanitarians on this thorny subject; and to reiterate the views I expressed in 1912 as regards the supremacy of the B. Coli test.

In England slow sand filtration has been practised for a great many years, and the advocates of this form of purification have weapons in their armory which render their position almost unassailable. First of all, they have the evidence that initially impure waters have, after slow filtration, been supplied with apparent safety to consumers over a long term of years, and they claim, with good reason, that this honorable history is better than the opinions of all the scientists in the world. Secondly, they have the knowledge that slow sand filtration removes bacteria *of all sorts* from water to an extent unattainable by rapid or mechanical filtration without, and perhaps even with, the use of coagulants in *economical* amount. So true is this claim that users of mechanical filters almost invariably are driven to employ supplementary processes of purification—for example, coagulants or chlorine, or both these agencies. Lastly, they plead that the almost perfect way a slow sand filter removes all the living matters from water renders the process beyond the reach of criticism, and in this connection they justly point out that our knowledge of the causes of at all events some water-borne diseases is either speculative or not absolutely proved; hence, the all but complete removal of living "particulate" matter from a water removes the possibility of disease being caused by it, whatever may be the precise nature of the infective agent. In other words, they contend that whether A, B, C or X, Y, Z are the responsible agents, by removing the whole alphabet all the known or unknown causes of disease are eliminated.

On the other hand, the advocates of mechanical filters justly point out that slow sand filters are not well adapted to certain climates and to particular kinds of water. Most of them indeed go much further than this and claim that with the aid of coagulants and chlorine, as good or better results can in all cases be achieved with mechanical as with slow sand filters, and at equal or less cost.

The use of mechanical filters, coagulants and chlorine is extending very slowly in England, but in the United States and Canada it is the almost universal custom to rely upon these agencies separately, or in conjunction, for the purification of water. Within recent years there have arisen out of this some elements of controversy which require delicate handling.

There is no doubt that chlorination has led, perhaps not unreasonably in view of its apparent effectiveness, to what may be termed "short cuts to purity." It is to be seen in its most transparent guise when impure water is sterilized, in lieu of any filtration process, directly by means of chlorine. In less transparent form it crops up in connection with rapid filtration processes and is usually to be regarded not so much as an additional safeguard as an admission that the filtration system adopted is only relatively satisfactory.

The advocates of sterilization say that the crux of the position lies in the destruction of B. Coli, and certainly this microbe is the most amazing indicator of a potential danger that could possibly be conceived, in view of the fact that one gramme (about 15 grains) of human faeces harbors at least one million, and that in pure waters it is absent from one hundred or more times this amount.

Nevertheless, there are epidemiologists, bacteriologists and others who, with no ulterior object to serve, are opposed to chlorination. They plead, among other things, that chlorination is often the cloak to cover imperfections, and that frequently the dose is governed less by questions of safety than by those of taste. This question of taste is truly one of paramount importance. Those who seek to evade its embarrassing features by reducing the dose of chlorine are often unconsciously flirting with danger.

In addition a school has arisen whose pupils directly challenge the supremacy of the B. Coli test. In effect the position is strained, but the writer is not one of those who imagines that controversy on this subject is gov-

erned by other than purely altruistic considerations. The writer has sought to place himself in sympathetic touch with current opinions, but he is faced with the circumstance that many of the views expressed on the subject are, owing to our imperfect knowledge, so indefinite as to verge on the nebulous.

Some Doubt Whether B. Welchii is a Spore Former

There seems, for example, some element of doubt whether B. Welchii is a sporing or non-sporing microbe. In England it is regarded as a spore-bearing organism and many consider it as identical with B. Aerogenes Capsulatus, if not with B. Enteritidis Sporogenes (Klein).

D. D. Jackson, Columbia University, New York City, considers that B. Sporogenes and B. Welchii are absolutely distinct (see *Engineering News-Record*, June 9, 1921, and particularly the table on p. 1002).

However, if for the sake of argument it is convenient for the moment to suppose that B. Welchii is a non-sporing and even pathogenic microbe, where does this view lead us? Not very far, the "chlorinators" will say, because chlorination presumably would destroy it equally with B. Coli. Certainly it is a fact in the writer's experience that when a river water is being chlorinated *successfully* the number of bacteria growing in agar at 37 deg. C. is practically identical in (a) unheated cultures and (b) in cultures previously heated to 80 deg. C. for ten minutes to kill all but sporing organisms. (Curiously enough the "heated" cultures tend to yield slightly higher results than those which are not "heated.") The obvious inference is that if there are any pathogenic non-sporing microbes in water they will be destroyed by the chlorination process.

The foregoing remarks refer to aerobic cultures (heated and unheated) but the writer thinks that anaerobic cultures would yield comparable results. He, of course, admits that even among the non-sporing bacteria there are degrees of resistance to chlorination treatment, and that where the dose is unduly reduced some may survive, although the majority have perished. Nevertheless, his experience has been that if the treatment is pushed to the extent of destroying B. Coli, practically all the other non-sporing microbes also suffer extinction. When we come to consider sporing germs the case is widely different, for even the "chlorinators" will readily admit that it is impracticable to kill the spores of bacteria.

Can Any Spores Cause Gastro-Enteritis?

The writer proposes to disregard the identity of B. Aerogenes Capsulatus, B. Welchii, B. Enteritidis Sporogenes, etc., and ask himself the simple question, is there any convincing evidence that the spores of any microbe are capable through water supply of causing gastro-intestinal disturbances?

Gastro-intestinal disorders are not uncommon; they are frequently associated, rightly or wrongly, with errors in diet, tainted food, impure shellfish, contaminated milk, high temperature, sudden chills, insanitary conditions, influenzal epidemics, etc. Communities enjoying the use of water supplies from virgin gathering grounds suffer from them, and it has still to be proved satisfactorily that populations less favorably situated in this respect and consuming chlorinated waters are affected to an abnormal extent.

Our milk supplies, from the udder of the cow to the mouth of the consumer, sweat with opportunities for spore infection. The writer would hesitate to accept any evidence implicating a water supply as a causative factor in the production of gastro-intestinal disorders *through the medium of spores*, until he was satisfied that the milk supply, at all events, was fully exonerated. Nevertheless, it must not be concluded from this that the writer considers that milk is *necessarily a potent* factor in creating the symptoms which characterize obscure intestinal affections.

Many of us believe that infections are largely caused by some accidental circumstance which sets free a great army of hostile invaders (e.g., the discharges of a "carrier") or, alternatively, and less convincingly, by bacilli possessed of such intense morbific power that even singly they can overcome the natural resistance of the individual.

When we consider the distribution of spores in nature as compared with bacilli and consider that they are non-multiplying factors in connection with water supply, the writer feels that their numbers are in most cases insufficient to cause water-borne disease, unless one or a very few spores are sufficient to create infection.

B. Enteritidis Sporogenes Test, London

In London the B. Enteritidis Sporogenes test was carried out from 1905 on to the end of 1909 as regards the filtered waters, when it was abandoned as the results were always practically negative, but it was continued until March 31, 1916, in connection with the examination of the raw waters. Taking the year ended March 31, 1909, as an example the results were as follows:

B. ENTERITIDIS SPOROGENES IN LONDON WATER
In percentages of total samples examined

	—100 C.C. Per Cent	+100 C.C. or Less Per Cent	+10 C.C. or Less Per Cent	+1 C.C. or Less Per Cent	+0.1 C.C. or Less Per Cent
Raw Thames	40 3	59 6	26 9	3 8	none
Raw Lee	17 3	82 6	44 2	9 6	none
Raw New River	59 6	40 3	5 7	none	none
Filtered Waters	96 9	3 0	none	none	none

It is obvious that the test as applied to the filtered waters yielded practically negative results, and, unlike the B. Coli test, it gave no useful indication throughout the year of important fluctuations in the quality of the supply to the Metropolis. Even with the raw waters, positive results were largely confined to relatively large amounts of water, and when the writer compared the results with those yielded by other tests he decided, rightly or wrongly, to concentrate the work in other, and in his view more important directions.

An Indicator of Stormy Fermentation Only

It is of importance to note that the test was employed as an indication of "stormy fermentation" and not as affording proof of the presence of any particular spore to the exclusion of the spores of other anaerobes. The following quotation from p. 157 of the writer's "Studies in Water Supply" will make this point clear:

The milk tubes are examined and those showing the B. Enteritidis Sporogenes phenomenon (gas formation, separation of the whey from the casein with precipitation of the latter) are registered as positive results. It may be objected that a variety of microbes may produce these changes, and the writer has always frankly admitted that he regards the test primarily as a test, and not necessarily as proving the presence of a particular microbe, and that microbe alone.

The above changes in milk culture were described by

Klein as characteristically typical of the growth of B. Enteritidis Sporogenes, and so it is both complimentary and convenient to retain the name, although the word *test* should be added as signifying that, in recording a positive result, one is not necessarily committed to the view that the characteristic changes are produced solely by one microbe, and that the one described by Klein. The practically important point is that sewages commonly yield a positive result with 0.001 c.c. and pure water a negative result with 10 c.c. or even more.

Apparently Dr. G. E. McLaughlin, Jersey City, adopts very similar views, for he says (*Engineering News-Record*, June 2, 1921, p. 929):

It may be objected that a variety of microbes may produce these changes, but I frankly admit that I regard this procedure primarily as a test, and not necessarily as proving the presence of any particular microbe, and that microbe alone.

In England the subject of the possible relation of spores to gastro-intestinal disorders does not lend itself readily to experimental investigations. Nearly all, if not all, of our large supplies are either derived from sources which are almost, if not quite, unimpeachable in character, or else they are subjected to very thorough processes of water purification.

In the United States and Canada the writer believes that the conditions are more favorable for comparative observations. That is to say, that there are many places where filtration is either not practised at all, or is admittedly imperfect, and where chlorination is relied upon to correct all the imperfections of an otherwise potentially "unsafe" water, and also a great many cities where the conditions of water supply approach the ideal.

A comparison between the two, bacteriologically (quantitative and qualitative spore tests) and epidemiologically (occurrence of gastro-intestinal disorders) would be of far-reaching importance, but it would necessarily have to be a condition of the investigation that in the former case the chlorination treatment was *really* effective in destroying B. Coli and allied non-sporing germs.

The writer conjectures that food (including milk) conveys to our alimentary tracts as many, or more, spores, than a water supply, although this is no convincing argument against the importance of reducing the risks (if there *are* risks) of infection to a minimum by purifying water to the highest standard possible.

Spore Theory on Insecure Foundations

The evidence that spores are, *through water supply*, instrumental in causing gastro-intestinal disorders rests, for the moment, on insecure foundations, and the writer cannot help feeling that in the presence of a chlorination process which really (and not merely nominally) destroys B. Coli in water, the danger of disease occurring has been unduly exaggerated. In cases where B. Coli is not killed, and therefore where other non-sporing bacteria of pathogenic sort escape destruction, the results may be different, but this, if it occurs, arises out of the imperfection of the chlorination process and is not, as the writer thinks, due to the presence of spores.

In the *Engineering News-Record*, June 2 and 9, 1921, pp. 929 and 998, there is an interesting summary of answers from 66 distinguished sanitarians to the question of the relation of B. Welchii to water-borne intestinal troubles. There are only two answers decidedly in the affirmative; one considers it doubtful, and all the rest either give no answer (presumably equivalent to "no conclusion reached"), or express views summarized as doubtful, not proven, no data, no proof, no, possibly, uncertain, and no more than B. Coli. This is not, to say the least of it, a concensus of opinion in favour of B. Welchii, or allied germs, being related to gastro-intestinal disorders.

J. H. O'Neill, New Orleans, says:

In the Summer of 1919, by request, the city bacteriologist of Shreveport tested for B. Welchii and found it in the Red River and Bayou water after rapid filtration and liquid chlorination. B. Coli is seldom found in the treated supply, but a large number of samples examined ferment lactose on the presumptive test. I believe there is some relation between these lactose fermenting organisms (probably in many cases B. Welchii) and the incidence of enteric diseases other than typhoid, *but I have no definite data.*" [The italics are mine.—A. C. H.]

Prof. D. D. Jackson, New York City, says:

They [B. Welchii and B. Enteritidis Sporogenes] are indicative of contamination in water, are both pathogenic to guinea-pigs and have often been found by the author and others in cases of intestinal disturbance, particularly among small children where the resistance is low.

B. Welchii Spores Not Proved Dangerous

The writer does not think that the presence of B. Welchii in diarrhea stools is evidence of its causative connection, especially in view of the fact that B. Welchii, B. Enteritidis Sporogenes, etc., are found in the discharges of healthy normal individuals. Nor is pathogenicity to guinea-pigs any proof necessarily of real harmfulness to the human species.

Further on Prof. Jackson says:

The occasional presence of organisms [B. Welchii and allied forms] of this character is becoming more apparent since the removal from water and sewage of a large proportion of the numerous other species by chlorine treatment, and much more attention should be paid to the determination of the presence of members of this group than has been the case in the past. It is evident that where such organisms are found in drinking water efficient filtration as well as chlorination should be applied.

The remaining affirmative answer comes from H. B. Larner, health officer, Montclair, N. J., but the writer has not been able to trace in the documents in his possession the exact reasons on which Mr. Larner bases his contentions. It appears, however, that in 1918 there was an outbreak of 1,625 cases of diarrhea in Montclair (population about 30,000) ascribed to the water supply, and so large a proportion of cases must, the writer thinks, have been caused either by milk or water. Again in 1921 a telephone canvass of physicians disclosed 187 cases of diarrhea.

In the earlier epidemic the water consumption was temporarily increased very greatly owing to the cold weather and war emergencies, and it also appears that the filters were by-passed so that unfiltered but chlorinated water was supplied to the inhabitants. The writer would greatly like to know whether during this period (1) the *uniform* destruction of B. Coli was definitely established, and (2) whether all possible causes, other than water supply, were eliminated satisfactorily.

[As to (1), in the account of the 1917-18, outbreak *Engineering News-Record*, Feb. 28, 1918, p. 432, it is stated that analyses made every three days up to about Jan. 15 and every day after that showed nothing unusual, which in the case of the Montclair supply means water of

a very high grade, so far as disclosed by analysis. Regarding (2): Detailed investigations by both the local and state health authorities convinced them that the water supply was the only possible common source of infection—EDITOR.]

The second epidemic (?) would have been more impressive if a canvass had simultaneously been made of some other towns, the water supply of which had not fallen under suspicion. If we are forced to accept both of these outbreaks of diarrhea as water-borne, the position is serious, as in 1921 the water was filtered as well as chlorinated.

SOME UNKNOWN FACTOR IN MONTCLAIR OUTBREAKS?

Having regard to the fact that a great many of the towns in the United States and Canada are supplied, so the writer is informed, with water, not only initially more impure, but apparently less perfectly treated than has seemingly been the case at Montclair, it is remarkable, to say the least of it, that similar and worse manifestations have not occurred wholesale. Have we been blind to comparable outbreaks at other places, or is there some factor in the Montclair situation, which, if known, would at once relieve our minds of all further anxiety?

The writer is in agreement with those who consider that the microbes causing "stormy fermentation" should be more thoroughly studied and classified, but this will take a long time, and meanwhile he thinks there is much common sense in the remarks of W. F. Wells, Albany, N Y.:

> Until more definite methods for classifying the B. Welchii group of organisms are developed it seems better for the impartial water-works operator to make a broad classification and not attempt to go into finer distinctions. Until some particular member of the group is discovered to have a pathogenic effect when taken in small numbers in drinking water it is only logical to assume that the wide distribution of the general group, and its common occurrence in drinking waters without any distinct result having been observed, makes its presence no cause for alarm.

Many other quotations might be made with advantage, and in selecting the opinion of N. J. Howard, Toronto, Ont., for special reference, the writer does so because it reflects so accurately the views of a large body of practical sanitarians:

EFFICACY OF CHLORINE IN CONTENTION

> If it can be clearly shown that B. Welchii is the direct cause of intestinal disturbance a very difficult controversy will arise, involving a radical change in present ideas of the efficacy of chlorine in eliminating water-borne epidemics. The results of *effective* [italics mine—A. C. H.] chlorination have been so conclusive that one hesitates to accept any such new theories, because, if the contention were a sound one, epidemics would be of frequent occurrence in almost all American cities.

It needs to be remembered that the controversy alluded to by Howard involves even slow sand filtration plants, although, doubtless not to the same extent, because they are relatively, and not absolutely perfect in the matter of elimination of spores. Indeed there is no water purification process in existence which is not involved in greater or lesser degree in the criticisms of the "stormy fermenters."

The writer's long and varied experience of matters relating to water supply has taught him the importance, in the interests of truth, of paying the utmost deference to the views of others. At the same time, he cannot help feeling that, in the present state of our knowledge, the importance of the "stormy fermenters" in relation to gastro-intestinal disorders and in connection with water supply has been unduly magnified.

B. COLI TEST STILL REMAINS SUPREME

As regards any doubts thrown on the supremacy of the B. Coli test the writer desires, in conclusion, to reiterate the observations he made nine years ago (*British Medical Journal*, Sept. 21, 1912) because he thinks that they remain equally true today:

Typical B. Coli (lactose +, indol +) is present in enormous numbers in excremental matters, and is absent from, or present only in small numbers in, substances free from undesirable pollution.

Typical B. Coli is a decadent microbe when divorced from the animal body; hence its presence in a water in any number probably points to fairly recent pollution.

Pure waters, general speaking, contain no typical B. Coli in 100 c.c. in a majority of representative samples; and incidentally it may be stated that impure waters can be so purified as to yield similar results at a not unreasonable cost.

Even so lenient a standard as "no typical B Coli in 1 c.c." of water in a majority of representative samples implies that the supply is not habitually contaminated with 1 gal. of sewage or its bacteriological equivalent, even in 100,000 gal. of water. The 10 c.c. and 100 c.c. standards (that is, no B. Coli in these amounts) obviously connote the absence of 0.1 and 0.01 gal. of sewage respectively from a like volume of water.

With the establishment of too severe standards there is danger of condemning reasonably safe supplies, and with too lax standards there is the possibility of passing waters which ought properly to be condemned. Always to steer safely between the Scylla of the one and the Charybdis of the other may be difficult or impossible without the aid of a pilot familiar with all the local conditions.

The B. Coli test ought primarily to be regarded as a quantitative decimal enumeration of "lactose +, indol +" microbes, but the subsequent grouping, according to certain attributes of the organisms thus obtained, into fairly stable or apparent varieties, may be of real practicable or diagnostic importance.

A SUMMATION OF VERDICTS

Standards are worse than useless if they are not interpreted with discretion and in relation to local and other conditions. Instances could be quoted where even similar B. Coli results ought properly to lead to dissimilar conclusions as regards quality and safety.

The B. Coli test even alone is of the greatest value, but a water supply should be finally judged on a summation of verdicts (geological topographical, physical, bacteriological and chemical).

The B. Coli test is by far the most reliable and speediest method of judging the degree of efficiency of the particular water purification process under investigation, and when a sterilization treatment is in operation, the certified destruction of B. Coli should afford absolute proof, practically speaking, of the divitalization of all the microbes of epidemic water-borne disease.

The B. Coli test having now survived the various vicissitudes of an earlier time, stands today as the most practical and delicate and rapid test for excremental filth, and may surely be taken as the most reliable indicator in its positive aspects of possible danger, and in its negative aspects of the almost certain absence of microbes associated with epidemic water-borne disease, and, generally speaking, as the one test which, above all others, it is least excusable for a water analyst to omit.

All the counts in the indictment charged against the B. Coli test when fully marshalled amount to no more than this: The test is only, or mostly, of relative, not absolute, value, and therefore the results should be interpreted with discretion.

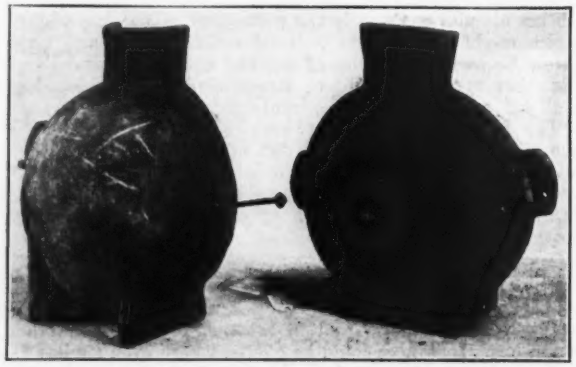
New Laboratory Abrasion Test for Concrete

With Spherical Test Pieces the Standard Brick Rattler Gives Definite Results in 900 Revolutions

By C. H. Scholer
Engineer of Tests, Kansas State Agricultural College, Manhattan, Kan.

For about two years the engineering experiment station of the Kansas State Agricultural College, in conjunction with the Kansas Highway Commission, has been studying the possibilities of a laboratory abrasion test, with standard apparatus, which would give definite results in comparing concrete mixtures for pavements. The nature of this study, which is now considered successful, is described in the following article.—Editor.

A NEW abrasion test for concrete is being developed by the Engineering Experiment Station of the Kansas State Agricultural College. The test consists of casting 9-in. spheres of the concrete to be tested and after proper aging and curing, submitting them to abrasion in a standard brick rattler using a standard abrasive charge. It has been found that the full hour's run of 1,800 revolutions is not necessary, 900 revolutions giving sufficient loss on even the toughest specimens to indicate the relative resistance to abrasion, offered by the material.



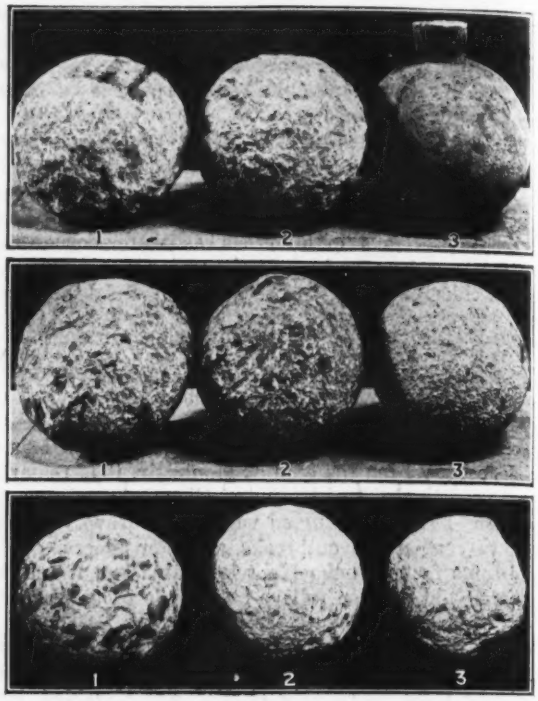
CAST-IRON MOLD FOR SPHERES

Spherical specimens were adopted after a trial of rectangular and cylindrical specimens because of the peculiar advantages offered by the spherical surface.

An examination of rectangular specimens after they are tested shows that a considerable portion of the loss is due to the exposed edges and that this loss is not a measure of the resistance to abrasion offered by the surface. The 9-in. spherical surface affords a very good approximation of the plane surface of a pavement especially as it relates to its resistance to abrasion.

The use of spherical specimens eliminates the necessity of a special type of rattler, as they can be tested in the standard brick rattler with the standard abrasive charge.

The first spheres were made in concrete molds cast over a wooden pattern. In one-half of the mold a 2-in. gate was left, through which the concrete was poured. These molds were thoroughly paraffined and oiled on the inside and little difficulty was found in removing the forms after the specimens were cast. After it was found that the test was practical, a number of cast-iron molds were prepared and are now used exclusively in casting the spheres. Considerable care had to be exercised in placing the concrete forms together so that the two hemispheres were concentric and there was also difficulty in puddling and ramming the concrete, lest the alignment of the forms be disturbed. The cast-iron forms can be jolted and rolled to eliminate air voids and further to compact the concrete.



(ABOVE) WISCONSIN GRANITE 1:2:3½ CONCRETE
(1) 10.2 per cent loss; (2) 11.1 per cent loss; (3) before testing, 28 days old.

(MIDDLE) GRAVEL AND CHATTS CONCRETE COMPARED
(1) Arkansas River gravel 1:2:3½ concrete 28 days old, loss 22.8 per cent; (2) same as No. 1, 21 per cent loss; (3) Joplin Chatts 1:3 concrete 28 days old, loss 35.5 per cent.

(BELOW) GRAVEL CONCRETE COMPARED
(1) Silverdale gravel 60 days, loss 11 per cent; (2) Arkansas River gravel 60 days, loss 17 per cent; (3) Arkansas River gravel 28 days, loss 29 per cent.

No difficulty is found in getting satisfactory specimens free from air pockets using concrete of proper consistency, with a slump of less than 1 in. Specimens are cast with a neck, which is left on until ready for testing when it is broken off with a hammer.

The storage and treatment of test specimens can be as seems desirable. In the laboratory, storage has been two days in the forms, nineteen days in water, and rest of the time in the ordinary dry atmosphere of the laboratory.

Because of the limited funds available for research work, no systematic studies have been made. The different tests to date have been on different aggregates using various brands of cement, so that results are not always comparable, and do not warrant the drawing of definite conclusions.

Series Nos. 3 and 12 were made using the same sand and cement with the exception of No. 5, as noted. The results are shown in Table I. This was the first series of tests made. Nos. 1 and 2 were tested at 7 days

TABLE I—VALUE OF FRENCH COEFFICIENT OF WEAR ON ABRASIVE RESISTANCE

No. of Test	Coarse Aggregate	French Coefficient	Proportion of Mix	Age 28 Days Loss in Per Cent	Average	Maximum Variation from Average	Age 90 Days Loss in Per Cent	Average	Maximum Variation from Average
3	Limestone	6 5	1:2:4	22 7 24 1 22 6	23.1	+1 0	9 3 10 1 10 6	10 0	0.7
4	Limestone	4 0	1:2:4	33 3 39 9 33 7	35.6	+4 3	25 8 29 0 24 2	26 3	+2.7
5	Limestone	4 5	1:2:4	18 6 18 8 18 5	18.6	+0 2	13 0 12 2 10 7	12 0	+1 0
6	Quartzite	13 5	1:2:4	12 2 12 6 13 8	12.8	+1 0	10 3 7 6 5 1	7 7	+2 7
7	Granite	18 0	1:2:4	7 8 8 3 8 0	8.1	+0 3		No data	
8	Limestone	4 0	1:2:4	38 2 39 7 31 9	36 6	—4.7		No data	
9	Limestone	6.6	1:2:4	16 1 20 3 17 2	17.8	+2.5	14 1 20 8 22 2	19 0	4.9
10a	Mine run chatts		1:3	21 2			23 5		
10	Mine run chatts		1:3	40 5 35 5	38.0	+2.5	20 4 20 5	20.4	
11	Pit run gravel 40% on ¼ in. screen		1:4	10 5 15 5 21 6	15.9	+5.7	8 6 12 5 13 8	10.6	3 2
12	Sand only		1:3	22 8 27 1 31 1	27 0	+4 2			

Notes: No. 5. A different brand of cement from others used in this test. No. 6. Coarse aggregate, too coarse for best results. No. 9. This specimen much denser than others, may indicate an error in proportions of mix. No. 10a. A well graded chatt. No. 10. Not so well graded as 10a, also a slow setting chatt.

and 14 days, with the result that the specimens were lost, the mortar not having sufficient strength to withstand the wear. This table shows the degree of uniformity given by each series and also the effect of age and the value of the French coefficient of wear on the abrasive resistance of the concrete.

TABLE II—MORTAR ABRASION TESTS ON CEMENT OF DIFFERENT BRANDS

	Age 28 Days, Per Cent Loss	Age 75 Days, Per Cent Loss
Brand A 1:3	37 3	25 6
Brand B 1:3	26 1	10 7
Brand C 1:3	52 0	34 3
Brand D 1:3	52 8	42 3
Brand E 1:3	31 8	20 8
Brand F 1:3	54 5	35 6
Brand G 1:3	22 4	15 4

Table II is a series of tests on mortar made with different brands of cement. This mortar was of rather an inferior quality. This shows that there is a marked difference in the wearing properties at early ages, of the mortar made from different cements, and from data on standard tests of the cement the resistance to abrasion was in practical agreement with the strength. In general, the properties which give strength might be taken as indicative of the resistance to wear.

TABLE III—RESULTS FROM SAME LOT OF CEMENT BUT DIFFERENT AGGREGATES

Aggregate	F. C., or Wear Value	Prop. of Mix	Loss in Per Cent 28 Days	Loss in Per Cent 60 Days	Crushing Strength 28 Days Lb.
Wisconsin Granite	18	1 : 2 : 3½	11.1	6.8	
		1 : 2 : 3½	11.2	8.0	3,010
		1 : 2 : 3½	10.2	6.9	
Wisconsin granite	18	1 : 1½ : 2½	8.2	3.8	4,930
Wisconsin granite	18	1 : 1½ : 3½	9.8	5.9	
Mortar, Blue R. sand		1 : 3	33.1	24.6	2,020
Ark. R. gravel-sand	15%	1 : 1 : 3½	14.8	13.1	2,660
Ark. R. gravel-sand	15%	1 : 2 : 3½	22.8	19.5	1,975
Ark. R. gravel, screenings and sand	15%	1 : 2 : 3½	21.0	16.7	2,390
Joplin chatts and jig sand	12 to 18	1 : 3 : 1½	14.9†		3,230
Joplin chatts jig sand	12 to 18	1 : 2 : 2	13.9†	15.4	2,810
Joplin chatts Blue R. sand	12 to 18	1 : 3 : 1½	29.4†	22.8	2,490
Joplin chatts Blue R. sand	12 to 18	1 : 2 : 2	15.1†	15.8	2,160
Mine run chatts	12 to 18	1 : 3	(35.6)*	10.8	3,960
Blue flint scr. sand	12	1 : 1½ : 2½	9.9	7.6	4,045
Yellow flint scr. sand	12	1 : 1½ : 2½	7.6		4,740
Unscreened yellow flint-sand	12	1 : 1½ : 2½	10.7		4,550

*Defective sphere. †Maximum aggregate ¾ in.

Table III shows a set of results which are more comparable, as all were made with the same lot of cement. They were, however, made at different times and represent a wide range of aggregates.

The results of the tests indicate that the method of testing is entirely practicable and possessed of several advantages over other tests so far developed.

A visual inspection of tested samples indicates the desirability of a coarse aggregate of smaller size than is commonly required for one course concrete work.

It is believed that the improved wearing value shown by the richer mixes used for the wearing course of a pavement is largely due to the finer coarse aggregate used in such mixtures.

The mortar bond on gravel or stone breaking with a glassy fracture is not strong enough to permit the use of this test at ages earlier than 60 days, as at earlier ages aggregate breaks out of its bedding.

It is not believed that smaller sized spheres would be practicable. Some 6-in. spheres were cast and tried out with unsatisfactory results.

To Reduce Time of Air Seasoning Wood

Although air seasoning of wood is an old practice, no systematic attempt has ever been made to work out exact conditions under which drying time and drying costs can be reduced to a minimum. In co-operation with the saw mills and wood utilization plants throughout the country, the Forest Products Laboratory, Madison, Wis., is organizing an extensive field study to determine piling practice which will result in the fastest drying rates consistent with the least depreciation of stock, the least amount of required yard space and the least handling costs. A comparison is to be made of the effects of such variables as sticker heights, spacing of boards in layers, heights of pile foundations and the direction of piling with relation to prevailing winds and yard alleyways. The study should settle the question of whether, from a business standpoint at least, lumber should be dried partly at the mill and partly at the plant of utilization or whether it should be completely dried at the mill, also whether air seasoning or kiln drying is the more profitable.

Safety Factors in Airplane Design

Reasons for Adoption of Low Factors Based on Abnormal Conditions—Successful Use of Long Columns

By Alfred S. Niles
Aeronautical Structural Engineer, U. S. Army Air Service, McCook Field, Dayton, Ohio

THE chief difference between the structural design of an airplane and that of a bridge is that instead of a safety factor of 4 or 5 a factor of about 1.75 or 2 is used. This statement may be startling to structural engineers in view of the fact that one of the chief structural materials used in airplane construction is wood; but further consideration of their problem will show that the airplane engineers are not as foolhardy as would appear at first sight.

In ordinary structures the load is applied at nearly all points on the structure and the supporting forces concentrated at a few points. In airplane work the reverse is the case most of the load being carried in the forward part of the body, the supporting forces being widely distributed over the wings and control surfaces. As a matter of common practice the supporting forces on the wings, etc., are usually spoken of as loads and the true loads, i.e., the weight of the airplane and its equipment, as supporting forces. In this sense the loads on an airplane may be divided into three classes: (1) Loads on the structure in normal flight; (2) loads during maneuvers due to the flight being in a curved path; and (3) loads resulting from impact in landing. Those in the first class are determined largely by wind-tunnel tests of small models, and to a much less extent by full-size tests in flight. Loads of the second and third classes are found by theoretical considerations checked by tests in the field. Once the loads acting on the airplane have been determined the structure can be resolved into its component beams and trusses and designed in the usual manner.

Pulling Out of a Dive

The loads in normal flight are comparatively small. The weight of the airplane plus its useful load must be balanced by the supporting air forces on the wings. When traveling in a curved path the airplane has an acceleration toward the center of curvature of the path, depending on its linear velocity and the degree of curvature of the path. In order to cause this acceleration there must be forces applied equal to the mass times the acceleration. As one pound of force is that force which will give a mass of one pound, an acceleration of 32.2 ft. per sec. per sec., the total force acting on the airplane will be $F = Wa/32.2$, where F is the force, W the weight of the airplane and a the acceleration in feet per second per second. The most severe maneuver for an airplane is pulling sharply out of a steep dive, in which case, it has been calculated, F may under exceptional conditions be as great as $15W$. Flight tests with an accelerometer made in England showed a maximum value actually obtained under service conditions for F of $4.2W$. Due largely to these tests and the fact that such airplanes have proved satisfactory, pursuit airplanes are designed to carry $8.5W$. This gives a true factor of safety of a little more than two, based on the flight tests.

As is indicated above, the abnormal loads on the structure are a certain number of times the normal ones in uniform level flight. The relative distribution of load is the same. For this reason airplanes are designed for a given "load factor." We would say that the pursuit plane was designed for a load factor of 8.5. Very often the load factor is incorrectly called the safety factor, but the practice is decreasing as it gives a false impression of the safety of the structure. For large airplanes which are not going to be maneuvered in the manner of pursuit planes, such as bombers or large commercial machines, the load factor used is less than 8.5 but is still chosen to give a true safety factor of about 2.

In landing, the body of the airplane is subjected to considerable impact. Comparatively little has been done to find out how great this effect will be. In fact it is impossible to put a maximum possible value to it. The only thing possible is to determine what it is likely to be when the landing is made by an ordinary skillful pilot under service conditions. For convenience this load also is expressed by a load factor, and the body is designed to carry from 4 to 7 times the weight of the airplane applied at the wheels and tail skid. The load factor in any given case is determined by what has proved satisfactory in airplanes of similar types. Large slow airplanes are designed for lower factor than fast pursuit or training ships.

It can be seen from what has just been said that, while the airplane has a low factor of safety in the abnormal conditions of maneuvering, the safety factor for normal flight is much higher.

Accidents Not Due to Structural Design

Several justifications can be advanced for the use of the low safety factor.

First, airplane design has proven generally successful. Very few accidents have happened recently due to faulty structural design. The chief causes of trouble are engine failure, fire, and reckless pilots. Where structural failure has occurred it has generally been due not to the use of a low safety factor but a faulty design in which the assumed safety factor was not attained.

Second, the maximum loads are temporary. It has been found that wood can be stressed far beyond the elastic limit, almost to the modulus of rupture, and if the excess load is removed in a few seconds the wood is not harmed. In the case of steel, the elastic limit is more than 50% of the modulus of rupture, so that the steel members will not be stressed beyond the elastic limit.

Third, the ultimate strength of struts is taken as the yield point in compression. In this respect airplane work varies considerably from ordinary structural work. In ordinary column formulas the maximum compressive stress on a column is taken as 16,000 lb. per sq.in., reduced for column action. This gives a factor of 4 when compared to an ultimate strength of 64,000 lb. per sq.in. But the yield point in compression is the true limit of the strength of a compression member, and as this is only about 40,000 lb. per sq.in. the true factor of safety for columns in ordinary structural work is only about 2.5.

Fourth, most of the struts used are very slender and can be computed by the Euler formula, which gives much more accurate results for long slender columns than any formula yet devised gives for the shorter columns. Slenderness ratios of from 150 to 200 are very common in airplane work. In this connection

reference may be made to a recent editorial in *Engineering News-Record* in which some doubt was cast upon the reliability of long slender struts. It has been found in airplane practice that such struts are perfectly reliable. The four D.H. airplanes which made the New York to Nome and return flight have as main structural members four pin-ended struts with a maximum slenderness ratio of 170 and four with a slenderness ratio of 220. As all four machines made this 10,000-mile flight without mishap the reliability of these struts (spruce) cannot be doubted.

Fifth, great care is taken to compute secondary stresses, so that part of the "factor of ignorance" can be eliminated.

Sixth, greater care is taken in inspection of material and workmanship than in structural work. Due to the care with which materials are selected a rectangular beam of spruce can be assumed to have a modulus of rupture in bending of 10,300 lb. per sq.in. instead of the 4,000 lb. per sq.in. which is used in structural work for ordinary spruce. Airplane designers make no allowance for knots, checks, etc., because such defects are cause for rejection of the material.

Seventh, most new designs are checked by a static test in which a full-sized airplane is loaded with sand or lead shot until destruction. In this way any weaknesses of fittings, etc., or errors in design are found out before similar airplanes are flown. This is always done where there is any doubt with regard to the strength of the design. In France the static tests largely take the place of theoretical analyses. In England the reverse is the case, reliance being placed chiefly on theoretical analyses. The U. S. Army steers a middle course, making a theoretical analysis and usually checking by static test.

If these considerations are taken into account, it will be seen that the design of airplanes with a factor of safety of 2 or slightly less is not the reckless practice that it would appear on first sight, but is a procedure necessitated by the requirements that not one useless pound of weight shall be found in the structure, and it is undoubtedly justified by the results which have been obtained.

Concrete Proportioning Tests Made at Washington University

In a thesis presented for the Degree of Bachelor of Science in Civil Engineering of Washington University, R. E. Salveter and E. J. Schewe investigated some of the current methods of proportioning concrete and arrived at the following conclusions. The colorimetric test for organic impurities in sand does not furnish an accurate basis for determining whether or not a sand is unfit for use in concrete. The slump test apparatus is very unreliable, especially in leaner concrete mixtures. There is need for investigations to disclose whether the consistency of concrete is dependent upon the surface area of the aggregate or upon some function of the fineness or grading of the particles. The water content in concrete is the most important single factor influencing strength, though the effect is more pronounced in early ages. The water-cement ratio has proved the most satisfactory of any of the methods for considering the water content of the concrete mix.

Tidal Bore Studies on River Dee and Its Estuary

Made in Connection with Investigations of Effect of Birkenhead Water-Supply Scheme on Navigation to Chester

By William Gore
of Gore, Nasmith & Storrie, Consulting Engineers, Toronto, Ont.

IT SOMETIMES happens that work in one branch of engineering leads to studies belonging to another branch. The following is an example in point where the promotion of a water-works project led to an investigation of a tidal bore.

When promoting a bill for new water-works from North Wales to take water from a tributary of the River Dee, the County Borough of Birkenhead, England, was opposed by the River Dee Conservancy Board, representing the Port Authorities of the ancient city of Chester. The basis of this opposition was that the

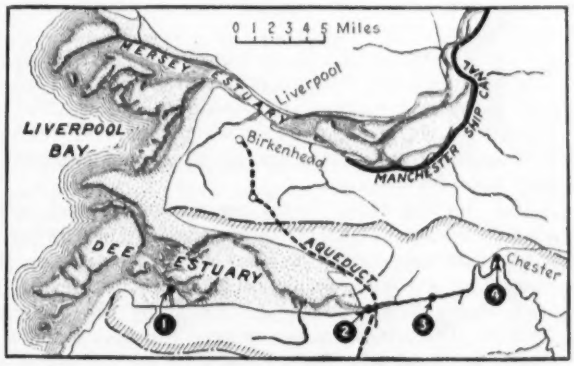


FIG. 1. ESTUARY OF THE RIVER DEE

diversion of the upland waters of the River Dee would deprive that river of some of the natural scour required as an aid in maintaining a navigation channel through the estuary of the river. It was alleged that the situation was a very unfavorable one owing to a tidal bore, 3 ft. high, which stirred up the sand in the estuary and in the bed and sides of the river and made the ship channel difficult to maintain.

It became necessary on the part of the borough to investigate the tidal phenomena in the estuary and river and the writer had charge of this work under the direction of the late Dr. George F. Deacon, consulting engineer to the borough.

A tidal bore is the beginning of a flood tide, marked with suddenness and distinction. Many tidal rivers or estuaries are subject to this phenomenon and probably the best example is that of the Bay of Fundy.

The bore of the Welsh River Dee was described a hundred years ago in De Quincey's "The Confessions of an English Opium Eater," as "a high, charging block of water filling the whole channel of the river and coming down upon us at the rate of forty miles an hour." He also used other terms and expressions of a more or less awe-inspiring nature. He at first supposed the long foretold event of Euripides, "the return of the fountains of the deep to their ancient sources," was about to take place. By reason of the terror that inspired De Quincey or for other reasons, his estimate of the velocity of the bore was probably several times too

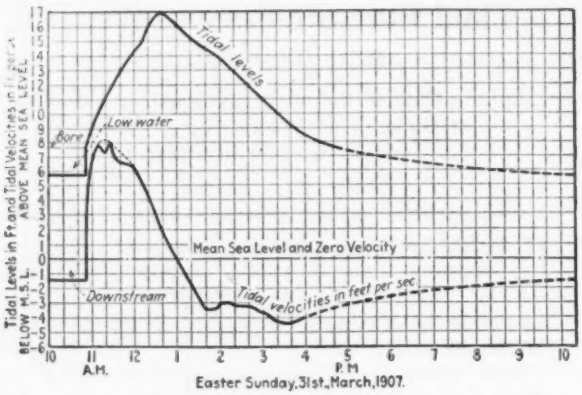

Tidal Levels in Ft. and Tidal Velocities in Feet per Sec. ABOVE MEAN SEA LEVEL BELOW M.S.L.
Tidal levels
Low water
Bore
Mean Sea Level and Zero Velocity
Downstream
Tidal velocities in feet per sec.
A.M.
P.M.
Easter Sunday, 31st. March, 1907.

FIG. 2. TIDAL DIAGRAMS OF RIVER DEE AT SANDYCROFT, AT EQUINOCTIAL SPRING TIDE, MARCH 31, 1907

Observations at Sta. 3, Fig. 1. The maximum tidal current upstream was 8 ft. per second. The tidal bore traveled upstream at the rate of 12 ft. per second, and the crest of the tidal wave at the rate of 20 ft. per second.

great, and in other respects his observations were unreliable.

It will be seen (Fig. 1) that the River Dee discharges into Liverpool Bay by an estuary fifteen miles in length and five miles wide at its mouth. At low tide the estuary is mostly sand banks which are ever shifting and changing so that the low water channel as shown is only approximate.

The highest tides travel up stream several miles above Chester, but the bore goes no further owing to a half-tide weir constructed for power purposes on the site of an earlier example of the 13th century. The four observation stations are shown by the encircled figures. The river channel between Stations 2 and 4 is mostly artificial and like a canal with embankments on either side which prevent the tides from covering considerable areas of low-lying lands. The low-water channel along this length is about 300 ft. wide, with a depth of water of from 3 to 5 ft. or more, depending upon the amount of upland water. It is along this channel that the bore reaches its maximum height and Station 3 was selected as the point of reputed maximum height of the bore for the more detailed examination of the tides and the bore. Stations 1, 2 and 4 were used only when tidal profiles were required. At Station 3 two cross sections were selected, 200 ft. apart, and the velocities of the bore and of the tidal currents were measured by the intervals taken to travel between the two cross sections. The tidal currents were measured by vertical rod floats 2 ft. long standing 3 in. out of the water and surmounted with small red or white flags. The floats were thrown into the center of the stream some distance above the nearer cross section and picked up beyond the further one.

The profile of the bore was determined by rods graduated in colors, driven into the bed of the river, and by strings of corks, which were photographed at and before the passage of the bore.

The observations took place over a series of daylight tides preceding and including a vernal equinoctial spring tide and one day following it. This period was selected so as to cover the highest tides. At this time the sun and moon are most nearly in a straight line with the earth and in consequence the resultant of the tide generating forces is a maximum.

The bore develops at high tides only; that is, at spring tides and a few tides on either side thereof. At the spring tides the bore commences about half way between Stations 1 and 2, reaches a maximum along the straight reach at Station 3 and gradually recedes until Station 4 is reached, when it suffers extinction at the Causeway Weir. At this point there is some evidence of a slight reflection back down stream.

Fig. 2 shows the tidal levels and velocities at Station 3 for the highest tide experienced. The sudden rise of level of 2 ft. at the passage of the bore is followed by an almost uniform rate of rise up to the highest point 1 hr. 40 min. later, followed by a nearly uniform rate of fall for 3 hr., which then gradually reduces until low water is reached. The velocity curve shows a sudden change from 1.4 ft. per second down stream to 3.5 ft. per second up stream at the passage of the bore, followed by a gradually decreasing rate of increase until a maximum of 8 ft. per second is reached 24 min. later. The tidal current then falls to zero in a further one hundred minutes. These are typical of the whole series of observations at Station 3, and differ very much from the almost simple sine-shaped generating tide

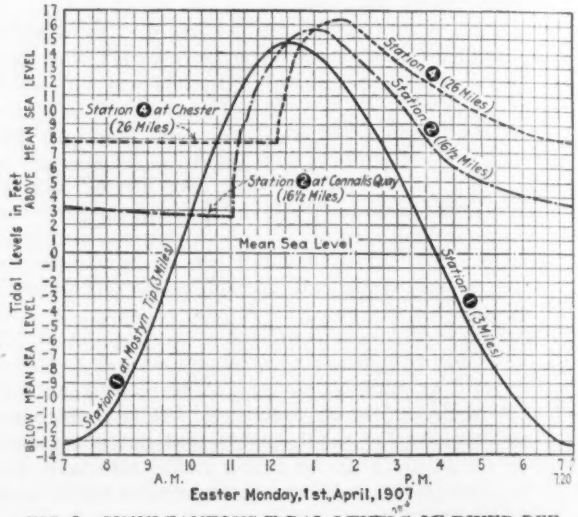

Tidal Levels in Feet ABOVE MEAN SEA LEVEL BELOW MEAN SEA LEVEL
Station 4 at Chester (26 Miles)
Station 4 (26 Miles)
Station 2 (16½ Miles)
Station 2 at Connahs Quay (16½ Miles)
Mean Sea Level
Station 1 at Mostyn Tip (3 Miles)
Station 1 (3 Miles)
A.M.
P.M.
Easter Monday, 1st. April, 1907

FIG. 3. SIMULTANEOUS TIDAL LEVELS OF RIVER DEE AND ESTUARY, APRIL 1, 1907

Observations 24 hours after vernal equinoctial spring tide at 3, 16½ and 26 miles, respectively, from Liverpool Bay.

curve at points near Liverpool Bay, as shown by observations at Station 1, Fig. 3.

In Fig. 3 are shown simultaneous tidal diagrams of a high tide 24 hr. following the vernal equinoctial spring tide. The range at Station 1 was 28 ft., that at Station 2, 13 ft. and at 4, 7.5 ft. The height of the crest of the tidal wave or the high-water mark, as it is called, rises with the distance up stream. The flood portions of the same tide is shown in profile on Fig. 4 to an exaggerated vertical scale for half-hourly intervals. Two kinds of bores or wave fronts were observed. These are also shown in Fig. 4 to a natural scale with the same vertical scale as the tidal profiles.

The photographs, Figs. 5 and 6, show the appearance of the bore. The greatest height measured was just under 2 ft. and the maximum velocity 12 ft. per second.

It will be seen that the bore is partly a smooth wave and partly a breaking one. Sometimes it is wholly smooth, at others wholly breaking and the changes from one condition to another are exceedingly rapid,

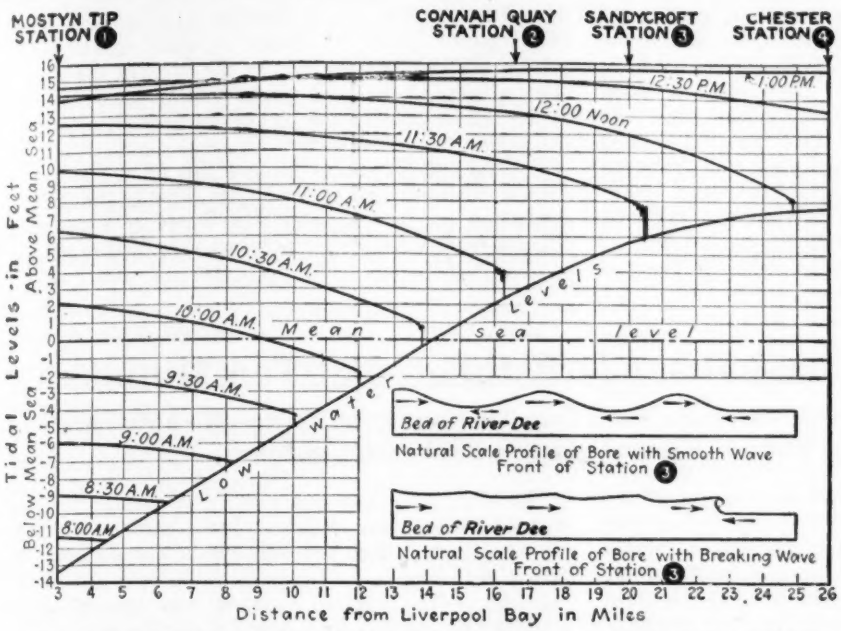


FIG. 4. TIDAL PROFILES OF RIVER DEE AND ESTUARY TAKEN AT HALF-HOUR INTERVALS, APRIL 1, 1907.

accompanied by much noise and turmoil. At the edges the water is turbid, showing erosion of the sides of the channel, which are more or less protected by stone pitching; but the turbidity spreads into the main body of the water at some distance behind the wave front.

Attempts by means of floats were made to determine the movements of the water in the bore but not very successfully. The ebb current immediately in front of the bore was about 1.5 ft. per second. In the case of the breaking wave the direction was reversed almost instantly but the wave moved forward much faster than the water. Thus, while the wave moved at 12 ft. per second, the water, until some distance back, did not reach half this rate. In the case of the smooth waves, there was a steady slowing up and a reversal before the crest of the first wave was reached, which was again reversed at the trough following. The same thing occurred with the succeeding wave, after which the float moved up stream at a faster and faster rate until a maximum of about 8 ft. per second was reached at a point more than a mile behind the bore.

The immediate cause of the bore is the rapid change in the direction and velocity of the water in the tidal channel. This is brought about by the main portion of the tidal wave traveling forward at a more rapid rate than the forefront. Thus, the crest of the tidal wave in this case was observed to travel up stream at the rate of 20 ft. per second while the bore moved at only 12 ft. per second. These velocities must be distinguished from the tidal currents, which in no case exceeded 8 ft. per second. Thus, during the flood tide, the rear portions of the tidal wave crowd upon the front portions more and more, producing a steeper and steeper forefront until instability is reached and the true bore is formed. The difference in the rate of travel of the various portions of the tidal wave is due primarily to the difference in the depth of the water. The wave velocities observed appear to follow very closely the formula $v^2 = 2\ g\ h$, where v is the velocity of tidal propagation in feet per second along the water and h is the depth from the surface to the mass center of the section of the channel.

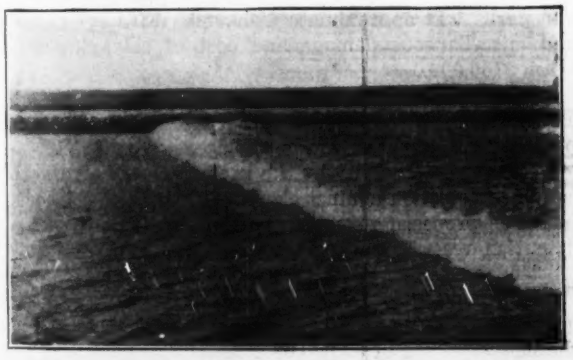


FIG. 5. VIEW OF TIDAL BORE ON RIVER DEE AT SANDYCROFT, MARCH 31, 1907

Taken at Station 3 (see map Fig. 1) at the beginning of an Equinoctial Spring Tide, which is the highest scheduled of a six-month period. The top of the rod in the center of the river, just in front of the bore, is 2 ft. 2 in. above low water. Just back of this rod at 5-ft. intervals, are two others. At the time of the passage of the bore a strong wind was blowing from the right forward quarter.

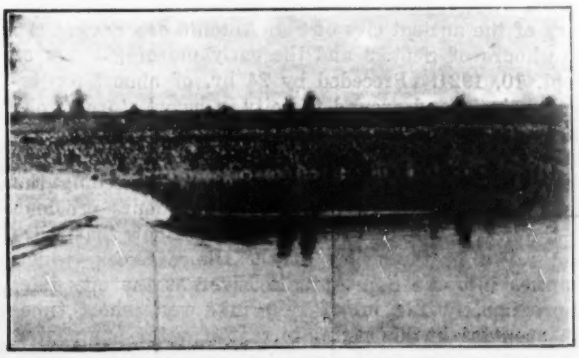


FIG. 6. TIDAL BORE IN RIVER DEE, MARCH 29, 1907

The white streak in front of the bore is a string of corks put in the river to form a profile. The nearer portions of the bore are in the form of smooth waves while the distant parts are broken. Interest in the phenomenon is added by its continually changing character.

Similar observations to the above made by the writer on the Manchester Ship Canal, indicated on Fig. 1, which at that time was partly tidal, did not disclose a bore, although subjected to the same generating tide in Liverpool Bay; but, as the water in the canal was 28 ft. deep instead of, say 4 ft., the forefront of the tidal wave propagated at the much greater rate of 30 ft. a second and was reflected back and forth over a reach of 12 miles in length until it faded away. In this case the formulæ for v also applied.

From the spectacular point of view it is to be re-

gretted that the magnitude of the Dee bore, as disclosed by the present series of measurements, was much less than that given by repute. This experience, however, does suggest that this class of phenomena is often magnified above its proper value by casual observers. At the same time it is well to state that the general appearance of the bore is very striking and somewhat startling to an observer at the edge of the river. Some of the more experienced local boatmen will ride the bore, but others scuttle to the shore when it approaches.

The outcome of the opposition was that Birkenhead agreed to pay the port authorities of Chester a small annual sum to cover the alleged increased cost of maintaining the ship channel, but as the borough discharges down stream at the head works continuously one-third of the whole yield of the reservoirs plus all overflows, the injury to the navigation interests must, if any, be very little indeed. From observations by the writer of several different tidal rivers he has come to the definite conclusion that a tidal bore is evidence of a defective channel from a navigation point of view, and is not the cause of the channel being defective.

San Antonio Flood Damage Estimated at Ten Millions

Rainfall of Phenomenal Intensity Brought by Storm Traveling North from Mexico—Much Pavement and Numerous Bridges Destroyed—Plan to Build Detention Basin

SUPPLEMENTING the brief telegraphic reports of the San Antonio flood of Sept. 10 printed in our news columns last week (p. 462), we give below further reports and data on the effects of the flood and the rainfall that caused it. The estimate of total loss given by the city engineer reaches the high figure of $10,000,000. Of special importance is his statement that a detention-reservoir project will probably be voted on shortly. The rainfall figures reported by the Weather Bureau confirm the early advices and tend to establish the southern Texas storm as among the most remarkable rainfalls of which definite record has been obtained in this country.

The Flood and Its Effects

By D. D. Harrigan
City Engineer of San Antonio

The most extensive and destructive flood in the history of the ancient city of San Antonio occurred in the late hours of Sept. 9 and the early morning hours of Sept. 10, 1921. Preceded by 24 hr. of almost continuous rain in and around the city, a heavy storm broke in the evening of Sept. 9, accompanied by heavy rain from 7 to 9 p.m. The total rainfall in the center of the city during the twenty-four hours preceding the flood was approximately 8 in. A few hours previous to the heaviest of this rain the records show that there had fallen in the valley of the Olmos Creek, which empties into the San Antonio River at the city line, approximately 13½ in. of rain in a very short time. About midnight this raging torrent of water, augmented by the heavy local rain, swept upon the center of the city. By 2 a.m. of Sept. 10 a section of the city six miles long and from one-third to one mile wide was under water. Practically the entire business district was covered with from 3 to 10 ft. of water. In addition about two square miles of residence section were inundated.

From the approximate data obtainable at this time, it appears that about 20,000 sec.-ft. of water crossed the center of the city. The total property loss will probably reach $10,000,000, of which the city will probably lose about $800,000.

Paving.—Of the paving loss of $350,000, the principal item was more than 100,000 sq.yd. of wood block paving, the loss of this material being approximately two-thirds of the total yardage of this class of paving in the city. This experience will bar forever the use of wood block paving in San Antonio, except for patching on streets where the damage is not sufficient to justify replacing.

Bridges.—The loss to bridges was approximately $150,000, the largest item being a three-girder bridge on South Alamo St., over the San Antonio River. This bridge, which will require about $25,000 to replace, was built some ten years ago. Its destruction is due to the fact that the footings of the piers rested on gravel only 4 ft. beneath the bed of the stream. Due to the accumulation of wreckage against the bridge, a siphon was formed underneath the bridge which cut two channels between the piers, undermining the foundations and causing a total loss. There were sixteen smaller bridges completely wrecked, and thirteen badly damaged.

Other Public Property.—The loss to public buildings and parks will approximate $200,000. Fire equipment and miscellaneous damage and cost of salvaging will reach $100,000.

Within sixty days, weather permitting, all paving can be replaced, and within 120 to 140 days, weather permitting, all bridges can be replaced.

Protection.—The city at the present time has practically no protection against cloudbursts such as this one, but it is proposed to vote a bond issue to construct a detention reservoir above the city to regulate the flow of flood waters so that they may be confined to the channel, and the excess be allowed to run off in subsequent hours or days. This dam will probably cost in the neighborhood of $2,000,000.

The total loss of life will probably not exceed seventy-five.

Effect on Public Utilities

By Robert J. Harding
Vice-President and General Manager, San Antonio Water Supply Co.

Metcalf & Eddy, in their report of the city a year ago, indicated a possibility of a flood such as has occurred. The high-water level reached a point 6 ft. higher than has occurred in the last 35 or 40 years.

Lighting and Power.—The San Antonio Public Service Co., which operates the gas, electric and street car companies, suffered no damage to the gas works or to the gas distribution system.

One of the two power stations was considerably dam-

aged by the water filling the basements and covering the main floor, so that the service from a large part of this station has been out. This station also furnished the direct current in the city and operated the street cars, so that the street cars were immediately placed out of service. By Sept. 13 they were in operation again, however. The underground electrical system has been considerably damaged.

Water.—The San Antonio Water Supply Co., which operates two pumping stations in a direct system of water distribution, had both stations out of service on account of the water. The main station, however, was restored within 39 hours.

No material damage was done to the water works system. The hydrostatic level of the artesian wells was sufficiently high to maintain water service for one-half of the population, including the business district, and was sufficient for fire protection with the assistance of fire engines in this area.

Extraordinary Rainfall Due to Mexican Storm

By C. C. Clark
Acting Chief of Weather Bureau, Washington, D. C.

Complete reports of the Texas rainfall preceding the recent flood will not be available for two or three weeks, but below is given such a summary as we have been able to compile from the brief telegraphic reports received.

AMOUNT OF RAINFALL, INCHES

Station	Sept. 8	Sept. 9	Sept. 10	Sept. 11	Total
San Antonio	0.55	3.49	3.36	....	7.40
Boerne	0.22	6.44	.....	....	6.66
New Braunfels	....	9.38	....	....	9.38
San Marcos	....	8.00	1.50	....	9.50
Austin	0.20	0.78	18.24	....	19.22
Marble Falls	0.56	5.50	11.00	....	17.06
Cameron	0.76	12.46	0.84	....	14.06
Temple	....	0.34	9.00	2.54	11.88
Taylor	....	0.34	21.50	2.13	23.97
Georgetown	....	1.40	11.30	1.42	14.12

The separate values on Sept. 9 and 10 for Boerne, New Braunfels, San Marcos and Cameron are not strictly comparable with those given for the remaining stations, owing to a difference in the hour of observation, but the combined totals for Sept. 9 and 10 are comparable. Again, the rainfall given on Sept. 11 for Temple, Taylor and Georgetown really belongs to Sept. 10, as the rain evidently ceased during the early afternoon of the latter date. Observations are taken at 7 a.m. local time, and any rain after that hour would be recorded on the following date.

High Intensities—No details for periods less than 24 hr. have been received, except from Taylor, where it appears that the heavy rain began at 3:30 a.m., Sept. 9, and ended at 1 p.m., Sept. 10, a period of 33½ hr., during which time 23.63 in. fell. From 6:45 p.m., Sept. 9, until 7 a.m., Sept. 10, a period of 12¼ hr., 19.49 in. of rain fell, of which 3.61 in. fell between 8 and 9 p.m., Sept. 9.

The 24-hr. rainfall at Taylor, ending 11:41 a.m., Sept. 10, was 23.10 in. This exceeds all previous records for the state of Texas. The previous heaviest fall was 20.60 in. on June 28-29, 1913, at Montell, Uvalde Co., near the headwaters of the Nueces River. The one-hour fall of 3.61 in. has been exceeded quite often, and in various sections of the country.

Cause.—As to the direct cause of the excessive rains: In our opinion they were due to a storm that moved inland south of Tampico, Mex., on Sept. 7. At 7 a.m., Sept. 8, at Laredo, Webb Co., Tex., on the Rio Grande, a 24-hr. rainfall of 6 in. was reported; at Encinal, La Salle Co., Tex., about 40 mi. north of Laredo, 4.05 in. at 7 a.m., Sept. 9; and at Hondo, Medina Co., Tex., about 85 mi. north of Encinal, 5.70 in. at 7 a.m., Sept. 10, indicating a slow, yet steady, northward movement of the heavy-rain conditions. Apparently the excessive rainfall did not extend very far north of Temple.

A Long and Enviable Mayoralty Record

AFTER having been twenty-two times elected and four times defeated as candidate for mayor of New Bedford, prior to which he served as common councilman and before that for four years as postmaster of the city named, Charles S. Ashley has announced that he will not stand for re-election as mayor after the completion of his present or twenty-second term. He says that while he has enjoyed political life, he considers some thirty-five years of it sufficient—but puts in the saving clause "for the present."

On entering upon his twentieth term as mayor some eighty merchants and manufacturers of New Bedford presented him with a purse of $12,000 by way of appreciation of what he had done for the city in the past and encouragement for the future. At that time *Engineering News-Record* wrote to R. C. P. Coggeshall, known to many of its readers as superintendent of the New Bedford water-works for decades, asking for a few sentences of explanation and appreciation of Mayor Ashley's long and successful career as mayor. Mr. Coggeshall's reply has heretofore remained unpublished. It seems opportune to print it now in view of Mayor Ashley's recent announcement:

Charles Sumner Ashley is sixty years old [February, 1919]. He is a professional politician of high grade. In addition he has been a student of civic affairs, and for many years has been recognized as an expert in such matters, aside from their political aspects.

He is well equipped to become the general manager of any municipality, has a most vivid imagination, and forecasts the needs of this community several years in advance of its requirements. He views such problems broadly, leaving the details to be worked out by others under his direction. He is a great dreamer and his dreams are apt to come true.

Owing to the rapid growth of New Bedford for the past twenty years Mayor Ashley has had the good luck to see his visions mature in such a way that practical men of affairs rise up and call him blessed. The impetus due to his activities affect every city department.

He has replaced narrow ways in the business section of the city with wide avenues, reconstructed the fire department, enlarged the water-works, constructed new parks, new cemeteries, new and extensive sewers, and been instrumental in having other improvements made. Just now, in his private capacity, he is organizing a bank of which he is to be the president.

New Bedford has never been a follower of national party lines. For many years the issue has been Ashley or otherwise. The division comes upon some local problem. In national and state politics, Mr. Ashley is a Democrat. He was postmaster during Cleveland's administration and was first elected mayor in 1890. His term of office has not been continuous.

No man can live so long in the public eye without creating bitter opposition, and Mayor Ashley is no exception to this rule, but he has steadily made more friends than opponents, largely due to his winning personality. While he is a great politician, he never interferes or tries to influence the votes of the employees of the various departments. In all the long years we have been together he and I have never conversed upon the subject.

Problems and Progress in the Water-Works Field

Abstracts of Papers and Discussions Before the Annual Convention of the New England Water Works Association by Allen Hazen, George C. Whipple, Harrison P. Eddy and Others

Sanitary Protection of Water Supplies

By Allen Hazen
Consulting Engineer, New York City

I AM going to speak to you today about the relations between water supply and disease, and about what is done and may reasonably be done to keep public water supplies from carrying disease, and from ever being in a position where those who take the water may have well grounded anxieties as to the safety of the supply. I propose to discuss this matter in very general terms, and with particular reference to the developments of the last few years, that have put at our dipsosal new and most useful methods of control.

The question now presented is not so much how to keep our water supplies free from disease-producing qualities, for that question has been answered; but rather to see what precautions may best be taken to secure safety without duplicating to an unreasonable extent parallel lines of defense when this involves added cost and an unreasonable burden on the people who pay the bills.

Six Lines of Defense

[Mr. Hazen then reviewed the following six lines of defense: (1) Ownership and (2) sanitary supervision of catchment areas; (3) treatment of sewage from towns on catchment areas; (4) water purification by natural agencies—storage; (5) filtration, including pre-sedimentation and coagulation; (6) disinfection.—Editor.]

We need to know how to select those lines of defense that will give us the desired security with the least cost and with the least disturbance to existing desirable conditions. Often the answer will be found in the application of several lines of defense. For instance, taking the first one enumerated above—it will be worth while to buy and control, as completely as ownership gives control, certain parts of the catchment area. These parts will naturally be the areas along the streams and near the intakes and about the reservoirs. They may also extend to areas which, because of topography and other conditions, are more than unusually favorable for future occupation and pollution. The cost of the land must be considered. It will be worth while to buy large areas of cheap wild land. It will not be worth while to buy highly developed property that has been arranged to prevent pollution. Much protection may be secured by ownership, even though only a fraction of the whole catchment area is acquired.

Storage in large reservoirs often or usually helps in maintaining the safety of the supply, but it is not to be depended upon at all times. It fails to be reliable when heavy rains follow droughts that have depleted the reservoir. It has been one of the great elements in maintaining the sanitary quality of some of our supplies even though it is not efficient at all times. It is efficient most of the time, and the existence of storage on some of our larger water supplies has been a potent influence in reducing any disease-producing qualities which the water might otherwise carry.

The progress that has been made in the last decades in filtration and disinfection has been so great that the idea has sometimes been expressed that with such treatments it is no longer necessary to keep up other lines of defense. It has been thought by some that it was unnecessary to purchase lands on catchment areas for protective purposes, and that it would even be possible with the filtration of the water to sell great areas of such lands previously purchased. It has been suggested by others that sanitary supervision of the population on catchment areas could be reduced or eliminated when the water was filtered. Such ideas can hardly be accepted as representing sound judgment. The protection afforded by filtration and disinfection may be made very complete; but new discoveries are constantly being made, and new points of view are reached as more is known. The importance of each new advance is apt to be exaggerated at the time. Subsequent experience often shows unexpected drawbacks. We do not even know about all of the disease-producing qualities in water well enough to be sure that all of them are eliminated with the bacteria that we count, and on which present judgments of the efficiency of the processes are mainly based.

Chlorination, Filtration, Supervision

As chlorine kills nearly all the bacteria, we may logically let up on the rigidity of our filter requirements; but how much? Can we put the filter back to the point where it is only a rough strainer? Or is it not wiser to keep, even at added cost, the major part of the splendid efficiency that was obtained by the best filters before chlorine was used? And with these processes of filtration and disinfection in use is it not wise to retain to the full ordinary limit the sanitary supervision of rural populations developed before disinfection began? This is usually an inexpensive part of the protection and it certainly produces results in the safety of the furnished water supply.

Then there are the supplies, not very numerous to be sure, but there are very important examples, where the sanitary quality reached by the lines of defense already in use has been so high that it has not been thought necessary to use chlorine. Some of us may think, even in these cases, that the use of chlorine as insurance against remote contingencies would be worth while, but we must admit that results actually obtained without it leave little ground for criticism.

The standards of quality of public water supplies have increased and will no doubt increase still further. When water that caused only a few deaths replaced water that caused a great many deaths, the improvement was so great that it seemed at first to be wholly satisfactory. As years go by, and our students and laboratory men study the cases minutely and find out what is happening, they sometimes find that conditions might be still better. Standards are again raised and still better water is demanded. The art of water purification has advanced in the last decades to meet these demands. How far it has yet to go and how the best informed sanitarians of the future will regard the qualities of water now supplied can only be disclosed by the future. It is certain that polluted waters of years ago produced more disease and more deaths than can be accounted for by present theories of water carried disease. When we have stopped the bacteria that are counted in the laboratory, have we stopped all the disease-producing qualities of the water? That is what we do not yet fully know, and until that question is answered more conclusively than it can be answered today, and more conclusively than there seems to be, an immediate prospect of its being answered, we shall do well, within reason, to stick to all the approved lines of defense that are in use, and that can be economically maintained without going to unreasonable extremes.

In the meantime there is much to be done. Information is ahead of practice. There are opportunities in New England and throughout the country to secure added safety by the better application of well known methods; and it is for us to see that no promising opportunity is lost.

Discussion—Frank W. Green, Little Falls, N. J., suggested three minor lines of defense not mentioned by Mr. Hazen: (1) Typhoid inoculation of residents on river banks and in catchment areas; (2) education of doctors and nurses in care of typhoid patients; (3) provision of swimming pools to keep city populations from bathing in waters used for public supply. A. W. Folwell, New York City, called attention to dangers from the automobile camping places now becoming common. H. P. Eddy remarked on the necessity for vigilance, regardless of the number of lines of defense, as witness the recent typhoid epidemic at Salem, Ohio.

The Qualities of the Water Supplies of Massachusetts

By George C. Whipple

Professor of Sanitary Engineering, Harvard University, Cambridge, Mass.

IT IS a long time since a critical review of the water supplies of Massachusetts with reference to quality has been published. [The author then outlines the subject in general and presents and discusses analytical results in detail, with special relation to color, odor and other qualities coming under the general head attractiveness. Parenthetically he gives the average typhoid rate for the State of Massachusetts in 1920 as 2.5 per 100,000; the highest typhoid rate for any city as 10.7; and states that only five Massuchusetts cities had rates above 5 per 100,000. He presents a list of 24 Massuchusetts cities and towns having same kind of water filtration in use on Jan. 1, 1921, mostly small places. Only the concluding portion of the paper is given here.—Editor.]

The question, "Why are there not more filters in Massachusetts?", is one that is asked outside more than within the state. As a matter of fact, the water supplies of Massachusetts taken as a whole are well safeguarded and reasonably satisfactory to the consumers. The very low typhoid fever death-rate of the state has already been referred to. Yet, looking at the data for color, turbidity, sediment, and odor, it will be seen that very few of the surface waters are attractive at all seasons of the year. Even the water supplied to the Boston Metropolitan District is no exception, as microscopic organisms appear in large numbers in Wachusett Reservoir and the other reservoirs every few years. Lake Cochituate water in recent years has been notably unsatisfactory. These occasional unpleasant conditions cause only passing comment by the people, but the fact cannot be ignored that standards of quality are rising. With the supplies of most of the large cities of the country made brilliant by filtration, the supply of Greater Boston will before many years suffer by comparison. For many years, before the days of filtration, the water supplies of New England were of much better quality than those of the South and Middle West, but with the very rapid application of filtration to these naturally muddy waters the tables are being turned and the New England supplies, because of their color, sediment, turbidity, and occasional growths of odor-producing organisms, are coming to be of lower standard of attractiveness than the others.

Risks from Unfiltered Supplies

It must not be forgotten also that while the surface water supplies of Massachusetts are well safeguarded against constant pollution, any unfiltered supply is subject to accidental contamination. Heavy rains may suddenly wash polluting substances into the streams. The "turn over" of a reservoir, because of the disturbance of thermal stratification, may carry deposits from the bottom to the supply pipes of the city. There may be accidental infection resulting from the practices of boating, fishing, and ice-cutting. Storage in large reservoirs gives a high average factor of safety but may be subject to such irregularity that the chance of danger is one which should not be ignored. Almost every year, especially in the early spring, some city of the state suffers from the sudden occurrences of a mild type of dysentery, which is so general in its distribution that the public water supply would seem to be the only possible cause. These mild outbreaks seldom result in deaths, and the cases are not even reported. They come to the attention of the health officers informally, often through the press. They are usually of such short duration that by the time the epidemiologist and the sanitary engineer take up the study the bad conditions have passed. Outbreaks of this character have been reported during recent years in Wellesley, Norton, Medfield, Lancaster, Lynn, Northampton, Longmeadow, Cambridge, and elsewhere. Whether these dysentery outbreaks have been caused by water and, if so, whether they have been due to such an organism as B. Welchii, whether to a recent infection, or to the accumulated sediment on reservoir bottoms, is not known, but, if due to water, filtration will protect a community from infections such as these, provided the filtered water is not stored in an open reservoir.

In my opinion, the time is not far distant when the people will demand the filtration of all surface water supplies, and New England water-works superintendents will do well to keep this possibility in mind.

If filtration is to become general, the type of filter is a matter of importance and one which should already be receiving attention. Unfortunately, the removal of color from soft water is one of the most difficult problems of water purification. The exact nature of the reaction between alum and coloring matter is not yet known. Sanitary chemists used to say that all of the aluminum sulphate was changed to hydrate and that none of it went through the filter. Hiram F. Mills stoutly denied that this was so—although he could give no reason for it—and we are now coming to believe that he was right. The use of alum with short periods of coagulation and mechanical filtration of the ordinary type is, in my opinion, inappropriate to our soft colored Massachusetts surface waters. We must find some modification of the process which will be better, and I think this can be found. The corrosion problem in our state is serious already and must not be made more so by inappropriate chemical treatment. This is no place to enter upon a discussion of this problem, but it is one for the State Department of Public Health and for this association to study in all seriousness.

Should Give More Attention to Analyses

The water-works superintendents of New England should give greater attention to the analyses of the water supplies under their charge. Analyses are useless unless used. The state sanitary engineers and chemists use them constantly in the course of their supervision, but even this tends to become a perfunctory proceeding unless the superintendents show a co-operative interest. In 1917 the Health Commissioner of Massachusetts sent out a questionnaire relating to water analyses. In reply, 32 superintendents said they made no use of the analyses sent out by the State Department of Health; 19 said that they kept them on file; 18 said that they published them in their annual reports; 23 said that they occasionally show them to inquiring consumers; 28 said that they used them to compare present with past conditions; and only four said that they regarded them as having any important use.

All of the consultinging engineers who replied to the questionnaire were emphatic in their appreciation of the analytical work being done.

The results of this canvass must be regarded as a serious reflection on the interest which the superintendents of the small water supplies of Massachustets take in the quality of the water which they supply, and shows an over-confidence in state supervision. Since the active work of Mills, Stearns, Drown, and Sedgwick, a new generation of superintendents has come forward, and it is because the men of the present day need to have their interest aroused that the writer has brought together various facts and ideas which, for the most part, are not new and which are already well known to many of the members of this association.

Discussion—H. P. Eddy remarked that perhaps the reason why superintendents make so little use of the analyses sent to them is because a mere table of analytical data means little to them. M. N. Baker suggested that the water analyses should be correlated with the vital statistics of the city in question and urged that with the virtual elimination of typhoid as a water-borne disease the health authorities should bring forward a new measurement for the relation of water supply to health. Robert J. Thomas said that the old-time water-works superintendents are disappearing in Massachusetts and being replaced by mere formen, who cannot be expected to value and interpret water analyses. This change he attributed to the placing of the water service under departments of public works.

The Significance of Hydrogen-Ion Concentration

By Harrison P. Eddy
Of Metcalf & Eddy, Consulting Engineers, Boston, Mass.

THE term *Hydrogen-ion concentration* (also written "H-ions" and "P_H") may be paraphrased as *concentration of acidity or of alkalinity*, as the case may be. Pure water is neutral, and its hydrogen-ion concentration is taken at 7. Acidity is designated by numbers below, and alkalinity by those above 7. The acidity or alkalinity of a liquid has thus far generally been reported in terms of total quantity of acid or alkali present. The new hydrogen-ion method shows the intensity, or true acidity, rather than the total quantity of acid.

It has generally been supposed that the precipitation of the sulphate of alumina is dependent primarily upon the presence in the water of sufficient alkali and that any excess of alkali likely to be present in waters generally used as sources of water supply is not disadvantageous. However, certain experiments indicate that there is an optimum point at which apparently all of the aluminum is thrown out of solution, but that above that point on the side of alkalinity or below it on the side of acidity precipitation is not complete. This offers a plausible explanation of the presence in the water being treated of aluminum both in insoluble and soluble form at the same time and of the frequent occurrence of dissolved aluminum in filtered waters. It certainly indicates that it may be highly important, if practicable, to carry out the coagulation process at the optimum point of alkalinity—the isoelectric point. Without this determination, or its equivalent, it is impossible to know whether the water has the proper P_H. It may be too low or too high for complete precipitation and it will probably only occasionally be just at the optimum point.

Alkalinity and Hydrogen-Ions

Alum can be converted completely into insoluble aluminum hydrate only within a narrow range of hydrogen-ion concentration, which is not indicated by the methods commonly used for determining alkalinity, and either above or below this zone the aluminum or a portion of it, may be present in solution. It follows, therefore, that it is as important to reduce an alkalinity which is too high as to increase an alkalinity which is too low.

For ascertaining the isoelectric point the determination of the hydrogen-ions affords a convenient and practical means. This may be accomplished in a manner similar to that long used for the determination of the total quantity of acid or alkali present * * * * * or by means of electrical apparatus which indicates the relative conductivity of the water under examination.

In order to take advantage of the hydrogen-ion concentration in the operation of a water purification plant it will be necessary to control the chemical treatment according to several steps, such as: (1) Determine the quantity of alum required for successful treatment under conditions prevalent at the time. (2) Determine the P_H of the water to be treated. (3) Determine the quantities and kinds of chemicals to be introduced, in order to bring the water to the isoelectric point for coagulation of the aluminum.

The quality of most raw waters varies from time to time, often materially within very short periods. This variation may be in bacterial content, organic matter, numbers of micro-organisms, turbidity, temperature, or in all of these. It is obvious, therefore, that the quantity of alum must be varied to meet the conditions at the time. It is highly probable, also, that the P_H varies greatly and that the kinds and quantities of chemicals used to produce the isoelectric point must be varied accordingly. Even if the P_H of the raw water remained constant, the necessary changes in the quantity of alum introduced would make it necessary to vary the chemicals required for producing the isoelectric point, as this condition must be fixed with reference to the quantity of alum used, or in other words, if coagulation is to be complete the water must be at the isoelectric point after the suplhate of alumina has been added.

It has been suggested that the P_H of the water may be determined and the application of the conditioning chemicals regulated automatically by electrical apparatus. Such equipment would greatly simplify the control of the process.

Among the advantages which may possibly result from P_H control of water purification plants, may be mentioned the following:

(1) Prevention of passage of alum through filters and after-precipitation in mains. (2) Prevention of corrosive action. (3) Control of small plant and animal life. (4) Possible reduction in size of filter plant. (5) Possible increase in efficiency of operation. [Each of these five points was given a paragraph in the original paper.—Editor.] While these and perhaps a number of other advanages of the P_H control may be possible from a theoretical point of view, or may be obtained in the laboratory, it is important to prove to what extent, if any, they can be secured in the practical operation of water purification plants.

Thorough Investigation Warranted

There is little doubt that the determination of the hydrogen-ion concentration will permit of a more intelligent study of the water and the reactions taking place during its treatment. This fact alone is sufficient to warrant making a thorough investigation of the subject and determining the P_H value in many cases. It is possible that the methods of control now in use, based in part upon the older conceptions of the chemistry involved and in part upon practical operating experience, permit of as close operation of purification plants as it is possible to obtain, even with the assistance of the more delicate and refined hydrogen-ion determinations.

It often happens that empirical methods lead to practical results which are as satisfactory and effective as those based upon more accurate knowledge. This fact, however, does not justify disregard of progress in science and of new theories. It cannot be gainsaid that the older practitioners in any profession, or in the arts, are inclined to adhere to the older methods and processes as a result of their familiarity and experience with them and a natural reluctance to adopt new ideas. The older members of the profession should constantly guard against this tendency, in order that valuable improvements may not be ignored, simply because they involve new discoveries and new theories.

While it is wise to give proper weight to the reasonable doubt of success in order not to be misled by theoretical considerations, it is certain that the subjects of coagulation and filtration should be very thoroughly studied in the light of the more modern chemical theories. Such investigations will lead to a better understanding of the chemistry of coagulation than that which has governed this important subject in the past. With improved conception of the process, advantages of more or less importance are likely to follow. The true value of the hydrogen-ion determination can only be learned through investigations covering a great variety of conditions encountered at a large number of plants. Such investigations may well lead to a restudy of the whole subject of chemical treatment of water and improvements may result in lines entirely apart from the hydrogen-ion determination, which furnished the initial incentive for such further study.

Other Papers and Discussions

Bridgeport Water-Works—The plant of the Bridgeport Hydraulic Co. was described at the opening session by S. B. Senior, president. The supply is by gravity from impounding reservoirs. The company has built five concrete dams with its own organization, including an engineering staff, and has made preparations for building a sixth dam, 150 ft. high. It has engaged extensively in reforestation of its watersheds since 1906 and has two nurseries for the purpose. Owing to disease troubles of white pine, red pine has been planted for the last six or seven years. A jobbing department cuts and fells wood from existing forested areas. The company also uses available water power to run a jobbing grist mill.

Water for all public purposes is supplied without charge,

except that some $5,000 a year is collected for water delivered to schools and other public buildings, the rate for this service being 3c. per 100 cu.ft. and the total revenue from this source being only $5,000. No charge is made for water supplied to factories for private fire protection. Meter rates for industrial purposes are 4.4c. per cubic foot. Most of the domestic service is on a flat-rate basis.

Can High-Value Watershed Land Be Put to Profitable Use?—This question was presented by Mr. Senior, the problem being "to get adequate returns from rich farming land and at the same time protect the water supply." Some of the land bought by the company cost from $1,000 to $2,000 an acre. Mr. Senior said that the company could not get a return on the value of this land by planting it to conifers and that if it were left idle it would soon grow white birches, etc., and fall to a value of $35 an acre. Cropping with potatoes has shown a loss. Some of the land is now being put into grass. The company is experimenting with orchards, having planted 100 acres in apples, with peaches between in a portion of the area.

Discussion—Considerable discussion by various members showed no unanimity of opinion as to the possibilities of profitable utilization of such lands. Allen Hazen stated that the Spring Valley Water Co., San Francisco, owns about 100,000 acres of land some of which is of high value. It has an agricultural department which leases land for short terms—under restrictions, including one against plowing. This department has been profitable, but the Railroad Commission of California finds difficulty in auditing the accounts of the department [from the viewpoint of public policy evidently—EDITOR]. The company now talks of organizing an agricultural company to take the lands off its hands. Others who discussed this question told of the utilization of watershed areas for sheep grazing and for orchards, but on the whole the opinion seemed to be that for most water-works owning lands reforesting would be the best policy.

Control of Waste by House-to-House Inspection—Gordon Z. Smith, chief inspector, Bridgeport Hydraulic Co., described the company's system of house-to-house inspection to control waste. He said this is an integral part of the company's method of keeping control of its flat or schedule rate business, which appertains to nearly all the domestic supply. The inspection is made twice a year. Where leaks or other wastes are found and not rectified after due notice, the company sets meters on domestic services. Estimates indicate that any saving in domestic consumption effected by the universal meter system would be more than offset by capital and operating charges for the meters. Water from the various sources of supply is measured by Venturi meters. The percentage of unaccounted water is comparatively small.

Discussion—Opinions expressed by several in brief but spirited discussions were for the most part in favor of complete metering as fair and in the long run economical. M. N. Baker suggested that in the company's estimates of the cost of metering all domestic consumers, credit should be given for the postponement of the need for additional water supply to the saving in consumption effected by meters.

Monel Metal—This material and its suitability for water-works uses was the subject of a paper by H. S. Arnold, International Nickel Co., New York. The larger part of the paper was devoted to a discussion of this "natural alloy," obtained from nickel-copper ore. The advantages of the use of monel metal for valve stems, seats, etc., in chemical works, steam power plants, and water-works were outlined as well as of the use of the material for water screens and for use in filter and chlorination plants.

Discussion—J. M. Diven, secretary, American Water-Works Association, said water-works men would gladly pay double price for valve stems that would not break. Samuel E. Killam, Boston Metropolitan Water-Works, said that he had substituted a monel metal valve stem for a broken stem in a 36-in. hydraulic valve. The cost was some 75 per cent extra.

Leadite for Joints—An impromptu discussion on substitutes for lead joints brought out the fact that one of the winter meetings of the association will be devoted to this subject. Favorable testimony as to leadite was given by several speakers, including Lincoln Van Gilder, of Atlantic City, in which place leadite has now been used for nearly twenty years and almost wholly for the past fifteen years.

Disappearance of Coating from Cast-Iron Pipe Stored in the Yard—Mr. Killam told how pipe stored on his works had shown disintegration of coating, inside and out, after five to ten years. The outside trouble was located 2½ ft. from each end of the pipe, which led him to think that it was due to the rolling of pipe on skids at the works soon after it was coated.

Discussion—There was considerable discussion as to changes in character of coating since the manufacture of water gas has become almost universal. Allen Hazen said that he had recently been informed by the chemist of the Barrett Co. that while there is less old-style gas tar than formerly, yet it can be obtained. The Spring Valley Water Co., San Francisco, has a dipping tank in its yard for giving an additional coating to defective pipe. The discussion also brought out that such a tank is used at Springfield, Mass. F. A. Barbour, Boston, stated that the Association's Committee on Cast-Iron Pipe Specifications had decided to send a letter to the pipe manufacturers asking their co-operation in studies for better coatings.

Reinforced-Concrete Pipe—A paper on reinforced-concrete pipe for water-works purposes was read by W. G. Chase, of the Lock-Joint Pipe Co., New York City. It was illustrated by both lantern slides and moving pictures. The author stated that where the time used in the manufacture of the pipe is short a colloidal materal can be used for giving tightness and added that Abrams says that clay, which is cheaper than lime, can be used for this purpose up to 10 per cent of the amount of cement with a decrease in the strength of the pipe of 1 per cent for each 1 per cent of clay.

Chlorination of New England Water Supplies—A short paper on this subject by W. J. Orchard, of Wallace & Tiernan Co., Newark, N. J., brought out some facts as to the relatively small use of chlorination in the New England States. For the whole country, there are 1996 water supplies having municipal liquid chlorination plants for water and sewage, but only 128 of these, 12 of which treat sewage, are in New England, and of the number stated nearly half are in Connecticut. In Massachusetts only nine plants are using liquid chlorine. The Boston Metropolitan Water District is the only water-works of its size that does not chlorinate the water. The principal reason for the small use of chlorination in Massachusetts seems to be an objection to having water treated by any chemical. Notwithstanding all this, a considerable amount of the work on which the extensive use of chlorination elsewhere in the country is based was done in New England, including the experiments by Sedgwick and Phelps at Boston.

(Further abstracts will appear in subsequent issues)

Water-Works Laboratories Compared

In the report of Fuller & McClintock on the water supply of Kansas City, is a table shown below giving the water-works laboratory personnel and scope for several representative cities:

City	Pop. 1910 Thous.	Daily Consump., m.g.	Chief Chemist	Asst. Chemist	Asst. Bacter.	Lab. Helpers	Kind of Work
Indianapolis, Ind.	224	24.3	1	2	..	2	ABCDEG
Louisville, Ky.	224	26.0	1	1	1	..	ABCEF
New Orleans, La.	339	30.0	1	2	1	..	ABCEG
Grand Rapids, Mich.	113	12.4	1	3	..	..	ABCEFG
Minneapolis, Minn.	301	30.0	1	..	1	1	ABCDG
St. Louis, Mo.	687	98.0	1	2	2	4	ABCDEG
Albany, New York	100	20.0	1	2	..	1	ABCEFG
Cleveland, Ohio.	560	96.0	1	..	1	2	ABEFG
Columbus, Ohio.	182	20.0	1	3	..	..	ABCEFG
Cincinnati, Ohio.	363	50.0	1	1	..	1	ABCEFG
Kansas City, Mo.	248	50.0	1	..	1	..	ABG

A—Bacteriological.
B—Turbidity, Color, Odor, Alkalinity.
C—Sanitary Chemical.
D—Mineral.
E—Coagulants.
F—Microscopical—Planton.
G—Coal and Special.

LETTERS TO THE EDITOR

This department aims to be a forum for the discussion of the views of engineers and contractors. The range of interest should be as wide as possible. Contributors are, therefore, asked to make their letters short.

Time Units in Flow Duration Curves

Sir—I have noted with interest the letter published in *Engineering News-Record*, Aug. 11, p. 250, entitled: "Time Units in Flow Duration Curves" by Mr. Stackpole of the Maine Water Power Commission. Engineers interested in this subject might desire to know of the matter published in this respect in the Ninth Annual Report of the New York Conservation Commission, p. 477, which I prepared in anticipation of inquiries similar to that of Mr. Stackpole. There are given in that report duration curves for five typical streams of New York State, using both daily and monthly flow values. This annual report is available for general distribution.

EDW. H. SARGENT,
Senior Assistant Engineer,
Bureau of Water Power,
Department of State Engineer.

Albany, N. Y.,
Aug. 15.

"Normal" Construction Activity

Sir—*Engineering News-Record* of July 28 carries editorial comment with reference to certain figures showing the shipments of cement, stone, and sand and gravel for 1921 as compared with 1920. The following statement is made:

> "How is it then, if the construction industry is suffering so badly through inactivity, that the production and shipments of construction materials are so near to normal?"

The question naturally arises as to what is meant by that much-abused term "normal" as applied to the construction industry.

The year 1913, being the year previous to the starting of the World War, is frequently referred to as a normal year in the barometer of business activities. However, 1913 certainly cannot be considered as normal for the construction industry for purposes of comparison, for there was accumulated during the intervening eight years a vast amount of construction work, including the demand for housing, railway improvements, public buildings, and farm and factory structures, due to the fact that building activities were seriously curtailed during the war period.

Moreover, with the advent of federal aid in 1916, highway construction received its greatest impetus. Figures prepared by the Bureau of Public Roads show that the number of miles of state and state-aid roads built during 1920 was 98 per cent more than in 1914 and this figure, no doubt, can be applied to 1913 with equal verity. This percentage figure does not include repair work, nor does it take into account that the amount of highway construction and mantenance was seriously reduced during the war period.

Still further, 1920 cannot be considered a normal construction year, for during the last half of that year shipments of sand and gravel, stone, and cement were cut at least 50 per cent due to priority orders granted by the Interstate Commerce Commission in favor of the movement of coal and grain.

It is estimated that there is at least $1,000,000,000 now available for highway construction; that there is a demand for over 1,000,000 homes; that the railroads, in order to bring their maintenance of way work up to the required standard and make necessary extensions and improvements, will need to spend approximately $1,000,000,000. No estimates are available showing the amount that should be expended in public structures, nor for farm and factory buildings, but, no doubt, the needed expenditures for this sort of work would represent an enormous sum.

With this accumulation of deferred building work, can it be said that activity in the construction industry, as indicated by production figures of building materials, is anything like what it should be? In other words, neglecting the fact that there exists a general business depression, is there a normal amount of construction being done for 1921?

E. GUY SUTTON,
Executive Secretary,
National Association of Sand and Gravel Producers.

Washington,
Aug. 12.

Barbed Wire Fences Form Spur Dikes

Sir—A form of river bank protection that has been very successful along the line of the Fort Worth and Denver City Ry., in Texas, is composed of spurs of piling driven out from the bank pointing downstream. The piles are driven on 7 ft. centers, with the tops projecting above the high-water mark. On this piling is strung barbed wire on 4-in. centers from the river bed to the high-water mark.

SPUR DIKE MADE OF BARBED WIRE ON PILES

This wire effects a slowing down of the current that flows through it, causing it to deposit the sand or silt held in suspension, and building up a sand bar for some distance both above and below the spur. The spurs are more effective during flood time when more sand is carried by the water. The resultant sand bars start forming as soon as the water flows through the wires. The more sand the river carries in suspension, the more effective is the spur.

M. A. STAINER,
Engineer, Maintenance of Way,
Fort Worth and Denver City Ry. Co.

Fort Worth, Texas, Aug. 24.

Stresses in Horizontal Pipes on Rigid Saddles

Sir—There appear to be several typographical errors in my article on pipe stresses published in the Aug. 25 issue, p. 306, which I would like to point out for those who may want to use the article.

In Table I the column headings should read: ϕ, $T/\gamma r^3$, $M/\gamma r^3$, $\Delta_r/(\gamma r^3/EI)$.

In Tables II and III, with the exception of the first column, the headings should be values of θ, not ϕ. In Table II the coefficients are to be multiplied by Sr/π. In Table IV the algebraic signs defining the character of moments and deflections are not shown. There are several errors in the tabular figures, three of which, in column 4 of Table I and columns 4 and 10 of Table II, are considerable.

Under "Shell Stresses for Case II," in the final expression for W the limits of integration for the last two terms are θ and π, not zero and π. In equations (7a), (8a), (7b) and (8b), the first term inside the bracket should read $(\pi - \theta) \sin \theta \cos \phi$.

Under "Deflections for Case I," the second term in the first equation should be multiplied by 2, i.e. the 2 in the denominator should be omitted.

Tables II and III show values of equations (7) and (10), not (7) and (12). On p. 308, the ninth line from bottom of second column should read, "points Z_1 and Z'_1."

T. B. PARKER,
Captain 7th Engineers.

Camp Jackson, S. C.,
Aug. 30.

NEWS OF THE WEEK

New York, September 22, 1921

To Make Special Examination of Philadelphia Bridges

Thorough examination of all bridges in Philadelphia has been ordered by the Mayor, because of the bridge collapse at Chester, reported in last week's issue. No doubt is entertained as to the safety of any of the Philadelphia bridges, with the possible exception of the South St. bridge, which is old and in bad condition, and whose rebuilding is about to be contracted for. A special examination, however, is thought desirable to give complete assurance to the public concerning the condition of the city's structures.

War Department Reports Against Deeper Hudson Project

A report against undertaking the project to deepen the Hudson River from its mouth northward 116 miles to Hudson, N. Y., was sent to Congress by the Secretary of War Sept. 6. The report gives the estimated cost as $2,332,000 and points out that the improvement is desired chiefly in connection with the development of lumber traffic from the Pacific Coast via the Panama Canal, to the city of Hudson, where a large lumber terminal has been proposed. The report states that the project is not now justified and points out that it might be in the interest of economy to locate such a terminal farther down the river to avoid the expense of dredging a channel for the long distance proposed.

Bids Desired on Big Steel Pipe for Catskill Siphons

The Board of Water Supply of The City of New York is about to advertise for bids for the construction of mortar-lined and concrete-covered steel-pipe siphons along the Catskill aqueduct. The diameters of the steel shells range from 7 ft. 6 in. to 11 ft. 3 in., the inside mortar lining being 2 in. thick. The type of construction will be similar to that in the siphons previously built. (See *Engineering News*, Nov. 2, 1911, p. 526.) There are 14 siphons, at each of which two pipes are to be put in. The work will be divided into three contracts, one covering the territory from the Ashokan reservoir to the Hudson River, and two east of the Hudson.

The entire undertaking involves, among other items, about 500,000 cu.yd. of excavation, 100,000 cu.yd. of concrete, 20,000 tons of steel, 200,000 bbl. of cement and 2,000,000 sq.ft. of mortar lining inside the pipes.

Preliminary information may be obtained at the office of the chief engineer of the Board of Water Supply, Municipal Building, New York City.

Road Builders To Meet Jan. 17-20

The American Road Builders' Association will hold its next annual convention and exhibit of road building machinery and materials at the Coliseum, Chicago, Jan. 17-20, according to an announcement made this week by the board of directors.

Penstock Bursts During Tryout of High Head Plant

The Big Creek No. 8 hydroelectric plant which has just been completed in southern California was temporarily put out of commission during the tryout period due to the bursting of a penstock section near the power house. The plant has a capacity of 22,500 kw. and operates under a head of 680 ft. At the point where the break in the line occurred the penstock has an inside diameter of 6 ft., a thickness of 1 in. and is under a 580 ft. head. The damaged section of pipe was replaced and the plant was started again after a few days delay.

1,000-Mile Transmission Range Indicated by Million-Volt Tests

Tests were conducted at the high-voltage laboratory of the General Electric Co.'s Pittsfield (Mass.) works last week using voltages above 1,000,000 to determine whether the corona and spark-over characteristics at these enormous voltages follow the laws which have been established for voltages below 250 kv. As a result of the tests, which were made at 60 cycles, engineers of the company have concluded that it will be feasible to adopt considerably higher voltages for transmission than are now commercially employed. With the transmitting range permitted by 1,000,000 volts —namely, about 1,000 miles—it should be practicable to supply vast districts with power from the original source of energy such as waterfall, coal mine or oil well.

California Highway Bonds To Be Offered Oct. 27

A block of $5,000,000 worth of California highway bonds bearing interest at the rate of 5½ per cent will be offered for sale on Oct. 27, according to press reports from Sacramento, Cal. This is the second lot of road bonds to be offered recently by the state at this rate of interest. Reference to the earlier offering appeared in *Engineering News-Record*, July 28, p. 167. The present issue is expected to bring a premium of $30,000, as compared to the $19,550 premium on the previous issue, due to the improvement of the bond market.

Power and Irrigation Report on Deschutes River

Engineer Board Headed by D. C. Henny Submits Findings to Federal Power Commission

Utilization of the Deschutes River and its principal tributaries is discussed in a report just submitted to the Federal Power Commission by engineers comprising the Deschutes River Board and composed of D. C. Henny, consulting engineer of the Reclamation Service (chairman); Col. J. B. Cavanaugh, Corps of Engineers, U. S. Army, division engineer for the Northwest District, and Fred Henshaw, the Geological Survey's district engineer for the Northwest. The recommendations of the board are as follows:

That rights to storage in Upper Deschutes River be held withdrawn and be dedicated to irrigation and domestic use, with incidental use for power and industries involving a minimum flow of 200 sec.-ft. past Bend, and 50 sec.-ft. past the lowest irrigation diversion.

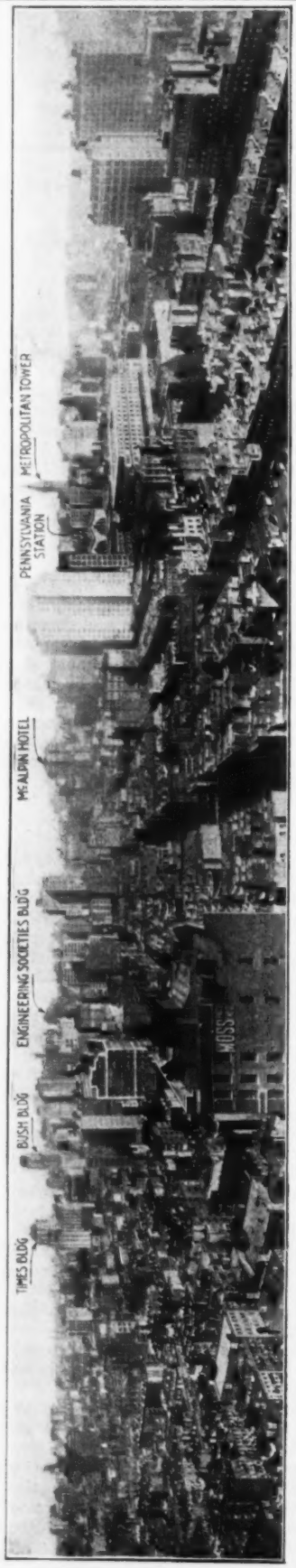
That rights to storage in upper Crooked River be held withdrawn for such use as may seem best in future, it being the present opinion that use for power with incidental use for irrigation in Crooked River Valley will prove most beneficial.

That Upper Deschutes storage do not exceed 525,000 acre-ft.; that possibility of heavy reservoir seepage losses be recognized in plans for storage development and disposal and that aggregate storage to be had with reasonable safety be assumed at not to exceed 350,000 acre-ft. at Benham Falls, and 80,000 acre-ft. at Crane Prairie until higher areas are flooded and greater storage is shown to be practicable.

That any storage development plan take into consideration the probable demands of old water right lands including the 50,000 acre-ft. storage space allowed by the State to the Tumale State Project.

That if storage rights at Benham Falls or Crane Prairie should be granted to interests other than the United States, these rights be limited to irrigation use subject to the maintenance of a minimum flow of 200 sec.-ft. past Bend and 50 sec.-ft. past lowest irrigation diversion for power and industries and to such other conditions as may be necessary to prevent undue monopoly.

That in view of the absence of any large market for Deschutes power and the doubt whether any of the large powers on Lower Deschutes can be developed profitably within the time contemplated by law after application for preliminary permit, all applications



MID-TOWN BUSINESS SECTION OF NEW YORK CITY, LOOKING EAST FROM ENGINEERING NEWS-RECORD'S OFFICE WINDOW—36TH STREET SHOWING PROMINENTLY IN MIDDLE OF PICTURE

LOOKING NORTHWEST ACROSS THE HUDSON RIVER FROM ENGINEERING NEWS-RECORD OFFICES

From the Editors' Window

Some time ago a Pacific Coast engineer called on us and brought his wife along. Both of them were much interested in the views of New York City, the Hudson and the Jersey shore from the windows of the editorial office. Believing that the same interest may be shared by others not familiar with New York we print in adjoining columns two views from our office windows. The one looking eastward shows the great pile of buildings which has grown up in the Mid-town office section of New York. The development shown extends along Fifth, Sixth and Seventh Avenues, and Broadway from about 23d St. to 59th.

The other looks northwest across the Hudson toward the Jersey shore.—*The Editors.*

To Construct New Buildings for Rose Polytechnic Institute

Construction work on the new Rose Polytechnic Institute buildings at Terre Haute, Ind., east of the city, will start within the next 60 days and the school will be transferred to the new location before June 1 of next year, according to an announcement by President Philip A. Woodworth.

The institute management has sufficient funds on hand to proceed with the work and bids on the work will be asked within a few days.

(*Continued from preceding page*)

for power at this time be considered as covering necessary investigations only and be handled by the Federal Power Commission so that ultimate development may not be hindered when conditions render such development economically practicable.

That no license be issued for development of water power on either Upper or Lower Deschutes which is not in harmony with the maximum development of irrigation.

That no license be issued for any project on Lower Deschutes which is not in harmony with the general scheme for the development of water power outlined in Water Supply Paper 344 of the Geological Survey until conclusive showing of an improvement upon this general scheme is made.

Port Authorities' Convention To Be Held in Seattle

The convention of the American Association of Port Authorities is to be held in Seattle Oct. 11-14. The program includes inspections of Seattle's port facilities, of the logging industry, the Bremerton Navy Yard, and the inland lakes of Seattle.

Pontoon Bridge Proposed to Relieve Seattle Ferries

Two Seattle engineers, R. R. Montell and J. H. Dirkes, have made an offer to the county engineers of King County (Seattle) to build two pontoon ridges across Lake Washington in place of ferries. They propose to use fifteen of the wooden vessels of the Shipping Board now moored in Lake Union, and estimate the total cost at $235,000 if the vessels are furnished without cost. The superstructure, built of wood, is to have 18-ft. roadways and 4-ft. sidewalks. The 3,000-ft. crossing from Seward Park to Mercer Island would consist of trestle approaches and ten spans on nine pontoons, while the crossing from the east shore to Mercer Island, 1,000 ft. long, would require three vessels. Draws would be provided in both bridges. In support of the plan it is stated that the present ferries are operating at a loss and that traffic would be facilitated.

Orders Rehearing of Cleveland Union Station Case

A rehearing in the Cleveland passenger terminal case has been ordered by the Interstate Commerce Comission. The proceeding has been assigned for Sept. 20. It will take place in the Federal Building at Cleveland before Commissioner J. B. Campbell and Examiner R. W. Clarke.

In the meantime Peter Witt, former transit commissioner of Cleveland, who opposed the Public Square project in hearings before the commission, has filed a brief with that body petitioning that it compel the building of a union station on the Mall site to be used by the New York Central, the Big Four, the Nickel Plate, the Baltimore & Ohio, the Pennsylvania, the Wheeling & Lake Erie, and the Erie Railroads.

Columbus Flood-Protection Work Near Completion

Scioto River channel improvement for flood protection of Columbus, Ohio, will be completed by the end of 1921 if the contractors are favored with fairly mild weather, according to R. H. Simpson, city engineer. The river channel has been widened from its confluence with the Olentangy River to a point south of the city. With the exception of some earth to be removed at the Broad, Town and Mound St. bridges all of the excavation has been completed. Approximately 1,000 ft. of levee must yet be constructed on the east bank and a small portion on the west bank. Nearly one-half of the concrete revetment is completed. The entire work cost about $3,500,000.

Louisiana to Legislate on Roads and Motor Vehicles

Bills dealing with the highway situation are expected to be a prominent feature of the special session of the Louisiana legislature which convened this month. A spirited fight is looked for on the tax on gasoline provided for by the recent constitutional convention where a maximum tax of 2 cents per gallon was specified. Advocates of lower taxation want the legislature to impose a levy of not more than 1 cent per gallon.

Another contest is expected on whether the State Highway Department shall be under the control of one commissioner or a commission of three members.

Submits Freight Belt-Line Plan for Flint, Mich.

According to recent announcement of officials of the Pere Marquette Ry., a plan for the construction of an 8-mile subsidiary line, to serve as a belt line for the diversion of freight traffic, has been submitted to the railroad company by the city of Flint, Mich. The Interstate Commerce Commission has already authorized the railroad to acquire control of the Flint Belt Railroad Co. It is the purpose of the plan to provide better yard facilities and to assist in the plan of civic development. The officials of the railroad hope to complete construction of the 8-mile line by the end of 1922.

Morgan Executive Chairman, A. A. A.

At a special meeting of the executive board of the American Automobile Association, held in New York City, Sept. 12, D. L. Morgan, of New Haven, Conn., was elected executive chairman to succeed the late A. G. Batchelder. Mr. Morgan, who has long been active in the good roads activities of the Pennsylvania Motor Federation and New Haven Automobile Club, has been at the Washington headquarters of the A.A.A. since July 1, as acting executive chairman.

Engineer Employment Status Shown by A. A. E. Statistics

During August a few more engineers applied to the American Association of Engineers for positions than in July, but there were more vacancies available. The following table shows the trend:

	Aug., 1921	July, 1921	Aug. 1920
Applicants for employment	2,320	2,215	1,303
Positions received	360	321	738
Men referred	2,250	2,567	3,502
Men placed	204	212	306

The most active fields are highway and municipal engineering and teaching. The average monthly salary of positions filled in August was $181, while for the same month last year it was $209. The highest paid position was for a city manager at $7,500 per year and the lowest a rodman at $125 per month.

Simplon Excavation Completed

Excavation of the second Simplon tunnel was completed Sept. 13, according to cable dispatches. The tunnel was being built by enlargement of the ventilation heading driven parallel to the first tunnel at the time the latter was constructed. The work was greatly retarded by conditions during and subsequent to the war. It is reported that traffic may be turned through the second tunnel by the end of the year.

To Promote Entente Cordiale Among World's Engineers

Several hundred American engineers will gather with representatives of the principal engineering societies of Great Britain and France at a dinner to be given at the Engineers Club, New York City, on the evening of Oct. 10. While formally celebrating the homecoming of the mission of American engineers who went abroad to confer the John Fritz medal upon Sir Robert Hadfield of London and Eugene Schneider of Paris. The event is planned to mark the launching of a world movement of engineers to promote unity among the English-speaking peoples and among peoples who aided in the war against Germany.

Invitations have been extended to many men prominent in public life, including Herbert Hoover, Secretary of Commerce, Viscount Bryce and Charles E. Hughes, Secretary of State. Others who will attend are the governing boards of the four national engineering societies, the trustees of the United Engineering Society and the officers of the Federated American Engineering Societies. British organizations whose representatives will be guests are the Institution of Civil Engineers, Institution of Mechanical Engineers, Institution of Mining Engineers, Institution of Mining and Metallurgy, Iron and Steel Institute, Institution of Electrical Engineers, and the Royal Society of London. France will be represented by La Société des Ingenieurs Civils de France.

Clifford Richardson, Asphalt Specialist, Retires

Was Prominent Figure in Development of Paving Practice in American Cities and Europe

Clifford Richardson, well known in this country and Europe as a specialist in asphaltic materials and paving methods, has announced his intention to retire from active practice Oct. 1. He will leave New York City, where for many years he has served as consulting engineer to the Barber Asphalt Paving Co., and will establish a residence in Santa Barbara, Cal. He was one of the pioneers in the investigation of bituminous materials for paving purposes, a field in which his early training as a chemist was a fundamental asset.

Mr. Richardson's first work, after he had graduated from Harvard in 1877, and taken post-graduate work at the University of Bonn, in Germany, gave little indication of the field in which he was eventually to become prominent, for he started as a chemist in the U. S. Department of Agriculture at Washington and was engaged principally in making studies of the adulteration of foods and the composition of American cereals. In these and similar investigations he was engaged for ten years.

Becomes Asphalt Inspector

One day in the year 1887, while at the Metropolitan Club in Washington, Mr. Richardson was accosted by Col. William Ludlow, then engineer-commissioner of the District of Columbia. On this same day E. A. DeSmett had resigned as inspector of asphalt and cement, under Col. Ludlow's direction, and the latter, knowing of Richardson's ability as a chemist and laboratory investigator, immediately offered him the position. Mr. Richardson accepted and began a campaign to place the selection of asphaltic materials for paving work on a rational basis. At that time practically all of the asphalt used in this country came from Trinidad, with a small amount also from Cuba, but the oil asphalts had not yet been developed. Asphalt paving specifications were exceedingly loose and ambiguous and there was practically no control over the material going into the work. Mr. Richardson set about fixing the proper proportions to use in sheet asphalt work and acted also as advisor on construction methods.

In those early days it was the practice to lay the asphalt to a thickness of 2½ in., with no binder course, the foundation often being of natural cement. Mr. Richardson's studies led him to conclude that the foundation of natural

cement was sufficiently porous to allow water from the subgrade to come in contact with the asphalt surfacing causing disintegration. With the introduction of portland cement concrete foundations, this trouble was largely eliminated.

Close Binder Developed

One of the first important developments in asphalt paving practice during Mr. Richardson's service with the government was the introduction of a binder course. As first constructed of broken stone and liquid asphalt, forming what was known as an "open" binder course, it proved fairly satisfactory until rapidly moving rubber-tired motor vehicle traffic became great. It was then found that pavement laid on an open binder course was shoved into waves by traffic, as the material in the binder course, together with the comparatively soft surfacing then used, was not sufficiently stable to resist the thrust from motor-driven wheels. This condition of affairs led to the development, largely through Mr. Richardson's efforts, of the "close" binder in common use today, in which the voids in the coarse aggregates are filled with asphaltic mortar. Mr. Richardson considers the introduction of the close binder as one of the important developments in asphalt paving and in its early endorsement he was joined by Capt. Symons of the Corps of Engineers.

When a change in the engineer-commissionership of the District of Columbia occurred about 1894, Mr. Richardson found his work less agreeable than under the old regime. Meeting A. L. Barber of the Barber Asphalt Paving Co., in Washington two or three months later, he told him of his dissatisfaction under the new conditions, and Mr. Barber promptly engaged Mr. Richardson to take charge of the field and laboratory work of that company's paving operations. He continued in Washington on this work and later (1906) went to New York in charge of the Barber laboratory in Long Island City. He has served that organization in a consulting capacity ever since, and his work has taken him into every state of the Union and to Europe.

Work on Thames Embankment

One of Mr. Richardson's notable engagements was on the paving of the Victoria Embankment in London. Heavy motor-vehicle traffic had made necessary a yearly resurfacing of the old macadam pavement, and on behalf of the London authorities W. C. Copperthwaite sent out a general invitation for a solution to the problem. Mr. Richardson went to Europe and proposed the surfacing of a section of the famous roadway with Trinidad Lake asphalt. He explained his project in detail and then asked what specifications it would be necessary to meet.

"There are none," he was told, "The job is yours. Do with it what you wish."

Under this broad authority Mr. Richardson laid about 800 sq.yd. of asphalt top surface on a base of asphalt binder near the east end of the embankment. The price, including two years' maintenance, was $2.17 per square yard. Other sections of the Thames embankment were paved in a variety of ways by other interests, but the asphalt paving was the only surfacing which remained after two years of service. These results led to an extension of the use of lake asphalt on the roadway and at the end of 1912 this type of surfacing constituted the entire area of the Victoria embankment from Black Friars Bridge to Westminster.

Thick Binder—Thin Top

Returning to the United States after the work in London had been completed, Mr. Richardson continued his service with the Barber company. Present-day traffic needs, he believes, make desirable a thicker binder course and a thinner wearing surface than were formerly employed. The surfacing, he points out, is only a protection for the binder course and might well be reduced to a thickness of 1 in., provided 2½ in. of close binder are laid to carry the heaviest kind of traffic. Today's traffic demands also call for an asphalt surfacing considerably harder than that used a decade ago, due, among other things, to the shoving effect of the wheels of automobiles and the softening of the pavement surface by oil droppings from motor cars. Mr. Richardson gave much study to determining the proper portioning of materials in the more recent top surfaces of asphalt pavement.

Mr. Richardson has been a prolific writer on subjects in his special field, among his principal books being "The Modern Asphalt Pavement." During recent years he has devoted much study to the colloidal state of matter in relation to the asphalt paving industry. His investigations have also related to the manufacture and constitution of portland cement and to the petroleum industry.

Fourteen States Tax Gasoline

In fourteen states taxes on gasoline are now operative, according to a recent statement by Harry Meixell, Jr., secretary of the Motor Vehicle Conference Committee, New York City. The tax is 1c. per gallon in all of the following states except New Mexico, where a 2c. levy is imposed: Colorado, Kentucky, New Mexico, Oregon, Arizona, Arkansas, Connecticut, Florida, Georgia, Montana, North Carolina, Pennsylvania, South Dakota and Washington.

Bills aiming to impose gasoline taxes were also considered this year by the legislatures of nine other states, namely, California, Illinois, Indiana, Maine, Michigan, Nevada, Ohio, Tennessee and Texas, but the measures failed to gain sufficient support to become laws.

It is estimated that $6,000,000 per year is now being collected from the gasoline taxes, which are in addition to the usual vehicle registration fees.

Convention of the New England Water Works Association

The registration at the fortieth annual convention of the New England Water Works Association at Bridgeport, Conn., Sept. 13-16, was 404. The program announced in *Engineering News-Record*, Sept. 8, p. 421, was carried out in full. The relatively few papers scheduled for each session gave full opportunity for discussion and avoided the confusion, haste, and postponement of papers to other sessions common with overcrowded programs.

The Dexter Brackett medal for the best paper printed in the *Journal* of the association during the past year was awarded to Robert Spurr Weston, consulting engineer, Boston, Mass., for his paper on lead poisoning from water supplies. The committee report on Water-Works Accounting presented at the 1920 convention and published in the *Journal* for March, 1921, was adopted after very little discussion, with about 35 to 40 members present. The committee report on standard specifications for water meters, printed in the *Journal* for June, was also adopted. This report covers disc meters only, although the committee expects to cover other types later on. The discussion on this report brought out the hearty approval of the manufacturers.

The Bridgeport Hydraulic Co., through its president, S. P. Senior, and other officials contributed largely to the success of the convention by the way of papers, discussion on the floor of the convention, and the provision of automobiles and escorts for trips to the various impounding reservoirs and chlorination plants of the company, and to the city sewage works, where there are installed two 20,000,000-gal. Reinsch-Wurl screens, each 26 ft. in diameter, and pumps with a total capacity of 48,000,000 gal., the entire installation of screens and pumps being electrically driven. Among other entertainment features provided by the Water-Works Manufacturers' Association was a picnic and short dinner after the close of the Friday morning session of the convention. There was also a visit to the Crane Co. valve works.

Attendance at the technical sessions of the convention was good the first two days, but dwindled rapidly on the third and fourth days.

Abstracts of a considerable number of the convention papers and discussions appear elsewhere in this issue or will be published later.

A. G. C. 1922 Annual Meeting to Be Held in Cleveland

At the mid-year meeting of the executive board of the Associated General Contractors of America, held recently at White Sulphur Springs, W. Va., Cleveland was selected as the city in which the 1922 annual meeting of the association will be held. St. Louis, Washington and San Antonio were other cities considered. The date of the convention has not yet been fixed.

Report I. C. C. Plan for Railroad Group Consolidations

Reports on a plan for the consolidation of railroad companies into large systems, as provided in the Transportation Act, purporting to be that suggested in a report made to the Interstate Commerce Commission by W. V. Ripley, professor of economics, Harvard University, have been published in the daily press. At this writing the commission has refused to confirm or deny the report, although it has been widely published. Under the Transportation Act the commission must render an official report outlining its recommendations for the consolidation of carriers into large systems, but it has no power to enforce the project.

The plan now reported proposes twenty systems, some of which are "alternative." Six systems would be formed in the northwest part of the country, exclusive of New England. Under one plan the New England lines would be included with the Lackawanna and other roads as the New England-Great Lakes System. From carriers in the southeastern section, five systems would be formed and five big Western systems would be built around the Union Pacific, the Burlington, the Milwaukee, the Santa Fe and the Southern Pacific. Two systems in the Southwest, known as the Frisco-Katy-Cotton Belt and Chicago-Missouri Pacific Systems, are suggested.

End One-Way Traffic on Broadway

As the result of a conference between representatives of business organizations in the Times Square district, New York City, and Dr. John A. Harriss, special deputy police commissioner, it is announced that beginning Sept. 15 one-way traffic on Broadway is to be discontinued for a period of thirty days. A change in traffic regulations, put into effect some months ago, restricted the use of Broadway between 38th and 57th Sts. to northbound traffic between the hours of 7 p.m. and midnight. The institution of these regulations, the business men claimed, was responsible for a considerable reduction in their income.

Plans are under consideration for the use of traffic signal towers, such as those employed on Fifth Ave., at Seventh Ave. and 42nd St., Broadway and 42nd St., Broadway and 49th St., and Broadway and 53rd St.

California Road Probe Refused By Governor

Governor Stephens of California, on Sept. 9, refused the request of the California State Automobile Association for an investigation into that organization's charges of waste and bad judgment in the construction of the state highway system. He maintained that "all reasonable demands" for such an inquiry had been met by the comprehensive investigation by the U. S. Bureau of Public Roads, which submitted its report Feb. 18.

Mississippi Valley Associations Forms Eleven Districts

The Mississippi Valley Association has formed committees representing various waterway districts to aid and promote waterway development. The eleven waterway districts represented by committees will be as follows: Intercostal Canal, Illinois River, Lower Mississippi River, Missouri River, Ohio River, Upper Mississippi River, Warrior River and the Great Lakes district. Committees representing the tributaries of the Ohio River and of the Mississippi have also been formed.

Engineering Societies

Calendar

Annual Meetings

AMERICAN ROAD BUILDERS ASSOCIATION, New York; Annual Convention and Good Roads Show, Chicago, Jan. 17-20.

AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS, Valparaiso, Ind.; Annual Convention, Baltimore, Md., Oct. 24-28.

CITY MANAGERS ASSOCIATION, Spartanburg, S. C.; Annual Meeting, Chicago, Nov. 14-16.

NATIONAL MUNICIPAL LEAGUE, New York City; Annual Meeting, Chicago, Nov. 16-18.

The Western Society of Engineers was addressed, Sept. 12, by A. R. Hirst, state highway engineer of Wisconsin, on "Developing a System of Highway Transportation to Serve the People of a State." On Sept. 19 Arthur E. Morgan, until recently chief engineer of the Miami Conservancy District, spoke on "Dayton Flood Control." Sept. 26 will be chief engineers' night and the society will learn of the experiences of C. A. Morse, chief engineer, Chicago, Rock Island & Pacific Ry.; A. S. Baldwin, vice-president and formerly chief engineer, Illinois Central R.R.; H. R. Safford, assistant to president, Chicago, Burlington & Quincy R.R.,and formerly chief engineer, Grand Trunk System; C. F. Loweth, chief engineer, Chicago, Milwaukee & St. Paul Ry., and E. H. Lee, Chicago & Western Indiana R.R.

The Allied Engineering Association, Charleston, S.C., has announced for the season a series of papers among which are: Oct. 17, "The Auto Truck—Its Use in Construction Work" by Lt.-Col. Eugene Kelly; Dec. 19, "Rebuilding Filter Plant, Charleston Water Department," Francis B. McDowell, Jr.; Jan. 16, "The Engineer and the Financier," E. H. Pringle, Jr.; Feb. 20, "Concrete Roads," James W. Martin; March 20, "Construction of Bridge Piers for the New Santee River Bridge," J. Bryce LaBruce; April 17, "Railroad Problems" J. P. Walker; May 15, "Paving of City Streets," J. H. Dingle. The officers are: President, J. E. Gibson; vice-president, W. L. Whitescarver; secretary and treasurer, T. A. Burbridge.

Personal Notes

ROBERT L. E. WARD, representative of the Weiland Engineering Co., Canon City, Col., has been appointed city engineer of Canon City.

WILLIAM CORMAN, formerly with the Gabriel Steel Co., is now chief engineer of the McRae Steel Co., Detroit, Mich.

PROF. L. S. SMITH, head of the highway engineering and city planning courses of the University of Wisconsin, has been appointed engineer of the Appleton, Wis., City Plan Commission.

R. M. CONNER, formerly project manager, Fort Peck project, U. S. Reclamation Service, with headquarters at Poplar, Mont., has been transferred to the Riverton project as construction engineer on diversion dam and canals to irrigate 100,000 acres in Fremont County. His headquarters are at Pilot, Wyo.

D. WALLACE BROWN has resigned as professor of engineering in the Royal Military College, Kingston, Ont., to become professor of mechanical engineering in the Nova Scotia Technical College, Halifax.

LIEUT.-COL. S. W. FLEMING, JR., of the firm of Gannett, Seelye & Fleming, Inc., has been appointed by Governor Sproul of Pennsylvania a member of the commission to investigate the battle fields of France and Belgium to mark the places where Pennsylvania units fought.

SAMUEL D. FOSTER, consulting highway engineer, has been appointed consulting engineer for the Allegheny County, Pa., Planning Commission.

GEORGE A. ARMES, president and general manager of the Moore Shipbuilding Co. of San Francisco, has resigned. Directors of the company, in announcing the resignation of Mr. Armes, who was an engineer, paid a high tribute to his skill. He is credited with having made a world's record in ship launching when six vessels were sent down the ways within an hour's time, as well as with several shipbuilding records including the recent completion of the oil tanker "Vacuum" in 115 working days winning the race for a world's record against the Sparrow's Point Shipbuilding Co. at Sparrow's Point, Md., where a vessel of similar dimensions was under construction. Mr. Armes was "loaned" to the Shipping Board by the Bethlehem Shipbuilding Corporation to handle their construction work and resigned this position to become the head of the Moore Shipbuilding Co.

CHARLES N. ROBERTS, consulting municipal engineer and surveyor, Chicago, has taken his son, Keith Roberts into partnership. Mr. Roberts, senior, has been engaged in the design, operation and construction of waterworks, sewers and paving, particularly of the North Shore suburbs, since 1889.

Keith Roberts is a mining engineer and until recently has been employed by Robert W. Hunt & Co. on examination of properties. During the World War he was an ensign in the Navy.

HUGH MILLER, since 1918 instructor in the Army Engineer School at Camp Humphreys, Va., has been appointed professor of civil engineering at George Washington University, Washington, D. C. He was graduated from Princeton in 1901 with the degree of C. E. and was an instructor in civil engineering at Princeton and later at the Harvard engineering camp. From 1900 to 1915 he was professor of civil engineering at Clarkson School of Technology, Potsdam, N. Y., and from 1915 until he entered the government service, he was lecturer in engineering at the Rice Institute in Texas.

OBITUARY

WILLIAM J. RODGERS, president of the Rodgers Granite Corp., New York, died in New York Aug. 31. He was 49 years old. For many years he was associated with his father John C. Rodgers in the contracting business under the firm name of J. C. Rodgers & Son. Among the large contracts he executed in this connection were two sections of the old rapid transit subway system New York, the Madison Ave. and Willis Ave. bridges over the Harlem River, the New York speedway and Riverside Drive. The Rodgers Granite Corp., of which he was president for the past few years, is operating one of the largest quarries in Maine, located at Stonington.

L. T. GOBLE, district engineer in the construction department of the Lakewood Engineering Co., Philadelphia, Pa., died Sept. 5. He had formerly been engaged in construction work in the West and was connected with the Allied Machinery Co., New York. His first assignment with the Lakewood company was at its Detroit office and, later, at the Philadelphia office.

EQUIPMENT AND MATERIALS

New Asphalt Block Press

In the National asphalt block press all stages in the making and discharging of blocks are automatically handled by the machine itself. After the hot mixture is fed to the hopper it is not again touched until the blocks are discharged from the water trough connected to the machine, at which time they are sufficiently cooled to be ready for storage or shipment.

The basic principle of the machine is hydraulic, but the hydraulic pressure is intensified by means of a system of levers. The maximum pressure obtainable is 400 tons. After the block is molded and compressed it is delivered to a belt conveyor which carries it through a trough of running water, in which the block is cooled and delivered to a platform ready for removal.

The press is designed so that it is readily adjusted to make the three standard sizes of asphalt block, 5 x 12 x 2 in. for light traffic, 5 x 12 x 2½ in. for medium traffic, and 5 x 12 x 3 in. for heavy traffic.

There is also a National press for making asphalt tile for walks and other light uses, and also a type which will make either paving block or tile.

The machine is made by the National Molding Press Corporation, 262 Fulton St., Brooklyn, N. Y.

Compact Road Repair Outfit

A compact road-repair outfit, sold by H. P. Andresen & Co., 1261 N. Clark St., Chicago, Ill., combines in a single device carrying capacity for materials

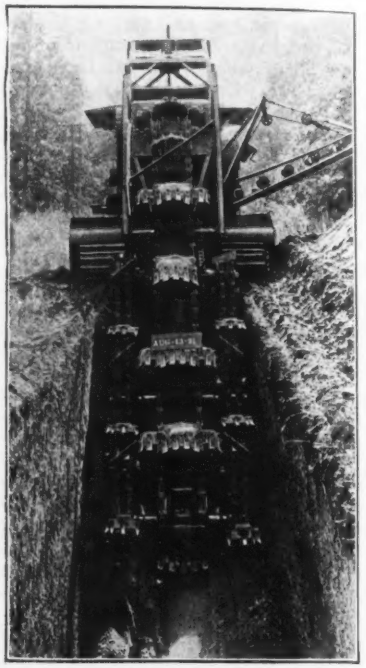
for repairing all types of roads. It carries a 125-gal. heating or melting kettle; two bins, each of 1-yd. capacity, for heating sand and stone; a combination mixing pan and tool carrier, a heater for tampers and smoothers; a coal-burning furnace; a coal bin of 350-lb. capacity; a cement box holding six sacks of cement; space on top of the bins for carrying materials and tools, and a hot shelf for keeping pouring pots warm.

The shipping weight of the outfit, mounted on 30-in. steel wheels, with 10-in. treads, is 5,500 lb.

Device Extends Width Limits of Trench Excavators

An attachment to a trench excavator which increases the width of trench that can be dug beyond the ordinary limit, which is the width of the throat through which the buckets pass, has been successfully developed by the Austin Machinery Corporation, of Chicago. This attachment can easily be made to any box-boom Austin excavator. In actual tests on a No. 0 machine, which normally digs trench a maximum of 42 in. wide, a trench 76 in. wide has been dug. The tests indicated that this width could be increased and further experiments will be made to determine the maximum.

The new attachment consists of endless chains, two on each side of the boom, to which are attached steel castings, to which are bolted teeth and side-cutters. These teeth merely rip up the dirt beyond the point where the regular buckets and bucket extensions dig. The scrapers, set diagonally between the castings, throw the dirt into the buckets that cut the core of



the ditch. These cutters and plows can be extended or made narrower.

In a ditch of 11 ft. depth, three shafts are necessary. These are inserted through holes in the box-girder boom and are reinforced with cast-steel hubs on each side of the boom. One shaft carries the upper sprockets, which are the driving ones, and another carries the lower idlers. The third or central shaft carries idlers to keep the chains from pushing over toward the center of the machine when hard material or obstructions are met.

Steam Shovel Mounted on Rubber-Tired Wheels

The Osgood Co., of Marion, Ohio, is now prepared to equip its Model 18, ¾-yd. traction revolving steam shovel with solid rubber tires. The purpose is to make a unit which can be moved over city pavements at considerable speed in going from job to job. The gears for self-propulsion can be disengaged so that the unit can be towed rapidly.

The tires are 40 in. in diameter and 14 in. wide, with ribbed treads. They are mounted on steel rims which are pressed on the regular 35 in.-diameter by 16 in.-face cast-steel wheels. This arrangement permits removal of the tires when desired. Cleats can then be attached to the rear wheels.

The tires are furnished by the Firestone Tire & Rubber Co.

Business Side of Construction

Facts and Events that Affect Cost and Volume

Reductions Made in Wholesale Prices of Cement

Cement manufacturers have announced a general reduction of cement ranging from 15 to 30 cents per barrel, which is already effective. The New York price alongside dock, to dealers, is now $2.10, as compared to $2.40, a price which has been in effect for several months. New York dealers, who for some time have been operating on practically no margin, have reduced their price to contractors 10 cents, making the present quotation $2.50 per barrel, net.

The price f.o.b. Chicago is now $1.97, which is a decrease of 20 cents. The decrease at Pittsburgh and Duluth plants is 15 cents. The Minneapolis price is now $2.26, as against $2.41, not delivered on the job. The new San Francisco price is $2.89, a decline of 20 cents.

Present prices in nine important centers are given in the regular weekly tabulation of basic materials quotations, on the following page.

Ohio Road Work Active

About 60 per cent more miles of highways have been built in Ohio up to Aug. 31 than were constructed in any previous year, according to a recent report of Leon C. Herrick, state highway commissioner. During the present year the department has completed 572.4 miles of highways; the highest previous mileage was in 1916 when 367 miles were completed. Mr. Herrick predicts that during 1921 at least 800 miles and possibly 1,000 miles of highways will be completed.

About 40 improvement projects are being delayed in anticipation of reductions in prices of materials.

Highway Work in Washington

Bids for eleven road contracts received by the Washington State Highway Commission and opened Aug. 30 constitute probably the last of the new road work to be authorized during 1921. Seven of the new projects are located in eastern Washington, and all will call for starting work this year, and finishing it in 1922. The state is now improving 187.29 miles of highway at a cost of $4,056,739.69. Thirty-five grading jobs and sixteen paving contracts are under way.

Maryland Road Contract Awards Completed for This Year

The State Roads Commission of Maryland has completed the award of contracts for this year. Since the beginning of the construction season contracts for about 160 miles of road had been let, involving an expenditure of roughly $3,500,000.

Activity on Road Work in California

Early in September there were 2,500 men employed on state highway construction work in California, according to estimates by A. B. Fletcher, chief engineer, state highway commission. Of this number, 1,500 were employed on contract work. Since Jan. 1, 1921, sixty-three contracts have been let, totaling in value $7,916,000.

Crane Business Improving

There has been a noticeable improvement in the derrick and crane business in the New York district recently, according to A. R. Ulbrich, general sales manager of the Terry Manufacturing Co. That company, within the past few weeks, has closed several orders for derricks and cranes, among them one for a tractor crane in Hoboken.

Ohio Plans Relief for Unemployed

Secretary of Commerce Herbert Hoover has received from Governor Davis, of Ohio, a telegram outlining that state's policy of relieving unemployment. The message was sent in response to Mr. Hoover's plea for the letting of road contracts during the winter. Governor Davis says, in part:

"Extensive roadbuilding contracts have been let. I am urging letting of additional contracts for new highways and hope to continue grading and other highway operations throughout the winter to relieve the situation.

"Additional appropriations are available soon for a large building program at state institutions. Ohio operates seven free employment offices in the larger cities through which it hopes to provide machinery for the placement of the unemployed. Ohio cities, as such, have not made appropriations for relief."

Recommend Unemployment Bureau for New York City

Acting upon the recommendation of the Mayor's Committee, headed by Bird S. Coler, commissioner of public welfare, the New York Board of Estimate and Apportionment on Sept. 7 made an initial appropriation of $25,000 for the establishment of an industrial aid bureau to deal with the problem of unemployment. The committee also recommended "that federal, state, and city governments be urged to commence at once and extend as far as possible all contemplated public works in and around New York City for which appropriations have been made." An appeal also was made to private employers to initiate work or proceed as rapidly as possible with work for which contracts have been let.

Brick Outlook Improves

Reports from 110 manufacturers of common brick in the United States on Aug. 1 indicate an improved condition in construction. Although stocks on hand are far in excess of orders, the increase in orders in relation to the increase in stock is in about the ratio of 3 to 1. This is the first month since the beginning of the year that the figures have revealed an actual upward trend in brick demand.

The number of plants closed is 35, the percentage being reduced from last month. Out of 110 plants reporting, 35 are closed, while a month ago the same number were closed out of a total of 92. These 110 manufacturers produce about 40 per cent of the common brick made in the United States. Stocks of burned brick on hand have increased from 198,169,000 on July 1 to 231,460,000 on Aug. 1, showing an increase in production for July. This is accounted for by the placing of orders amounting to 130,613,000 as compared with 73,562,000 on the books July 1.

Southern Pine Orders Show Notable Increase

Orders on hand for Southern pine were higher for the week ended Sept. 2 than at any time during the last three and a half years, with but two exceptions. Reports received by the Southern Pine Association indicate that orders held by Southern pine manufacturers averaged 706,459 ft., which is the highest on record since March, 1918, with the exception of two weeks in 1919. This week's orders are 30 per cent higher than those for the same week in August, and 62 per cent higher than during the corresponding week of last year.

Average shipments for the week of 603,496 ft. were also much larger than usual, being the highest reported since May, 1918. Orders received for the past three weeks have been greater than during any week since the middle of 1919, and show progressive increases.

Building Revival the Cure for Unemployment, Says Meyer

The general resumption of building operations will do more to put men to work than the revival of any other one industry. This is the recently expressed opinion of Eugene Meyer, Jr., managing director of the War Finance Corp. "The housing needs are large," said Mr. Meyer, "but building still awaits a supply of money on mortgage at reasonable cost and a settlement of labor conditions, as well as a readjustment in the cost of building materials. The revival of the building business

would put more men to work than the revival of any other one industry. It would mean direct and indirect labor in great volume."

Building Material Prices Lower in August

Wholesale prices of building materials in August were a trifle lower than in July, according to the indexed figures of the U. S. Department of Labor. The August index number is 198, a drop of 40 per cent from the peak, as compared with 200 in July and 328 in August, of 1920. The average price in 1913 equals 100.

Will Appoint Assistant Examiner, Patent Office

The United States Civil Service announces that an examination will be held October 5, 6 and 7 for appointment as assistant examiner in the United States Patent Office. Vacancies will be filled at the entrance salary of $1,500 per year with the bonus of $20 a month recently approved by Congress. Applicants should apply at once for Form 1312, stating the title of the examination desired, to the Civil Service Commission, Washington, D. C., or to the secretary of the U. S. Civil Service Board in any of the designated cities.

Distributers of Construction Equipment Meet

The National Distributers Association of Construction Equipment held a meeting in Milwaukee, Wis., recently which was attended by firm members and representatives of many of the largest distributers and manufacturers of construction equipment. Action to recommend that manufacturers adopt a standard size of catalog, to establish a trade-practice committee at the command of both manufacturer and distributer for ascertaining facts where differences arise, and to recommend that price lists be put on standard loose leaves, was taken.

Weekly Construction Market

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted. The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of September 1, the next, on October 6.

Steel Products:	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Structural shapes, 100 lb.	$2.88	$4.00	$4.00	$2.88	$3.16	$4.00	$3.70	$3.75	$4.00
Structural rivets, 100 lb.	3.70	5.25	5.50	3.68	4.15	4.25	5.50	5.00	6.50
Reinforcing bars, ¾ in. and larger, 100 lb.	2.78	3.25	3.50	2.78	3.18	3.57½	2.35	3.75	3.75
Steel pipe, black, 3½ to 6 in. lap, discount	51%	52.65-5%	45%	−65½%	−58.9-5%	−38%	46.25%	−55%	5%
Cast-iron pipe, 6 in. and over, ton	+47.30	40.50	53.30	45.60	−47.80	52.00	60.00	−55.00	70.00
Concreting Material:									
Cement without bags, bbl.	−2.50	2.69	2.80	−1.97	2.26	3.10	−2.89	3.10	3.10
Gravel, ¾ in., cu.yd.	2.25	2.13	3.00	−1.65	2.00	2.50	2.25	1.50	1.50
Sand, cu.yd.	1.25	1.35	2.50	−1.65	1.00	1.10	1.50	1.50	1.25
Crushed stone, ¾ in., cu.yd.	1.80 to 1.90	2.25	2.80	−1.75	2.25	3.50	2.25	3.50	2.10
Miscellaneous:									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft.	45.00	35.00	35.00	46.00	34.00	49.00	−28.00	+21.50	120.00
Lime, finishing, hydrated, ton	16.99	19.00	25.00	−18.00	29.00	30.00	25.40	24.00	21.00
Lime common, lump, per bbl.	3.69	1.60	2.75	−1.50	−1.40	2.95	2.25	2.75	15.00
Common brick, delivered, 1,000	18.40@19.40	10.00	12.72	11.00	17.00	14.00	18.00	14.00	16.00
Hollow building tile, 4x12x12, block	Not used	.14	.124	−.0821	.092	.09	.12½	.11	.15
Hollow partition tile 4x12x12, block	.11370	.14	.124	−.0657	.092	.10	.14½	.12	.....
Linseed oil, raw, 5 bbl. lots, gal.	+.80	.84	.98	+.87	+.91	.98	.91	.79	+.88
Common Labor:									
Common labor, union, hour	.75@.80	.35	.....	.72½	.50	−.50@.55	.81¼	.75	...
Common labor, non-union, hour	.....	.20	.35@.45	.35@.40	.50	−.35@.40	.50@.55	.50	.30

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or − signs. For steel pipe, the prevailing discount from list price is given: 45-5% means a discount of 45 and 5 per cent, 45@50 means a range of 45 to 50 per cent. Charge of 15c. per 100 lb. for cutting reinforced steel into 2-ft lengths or over. **New York** quotations are delivered except tiles, which are "on trucks." Common lump lime per 280-lb. net; both lump and hydrated quoted f.o.b. cars New York. Sand gravel and crushed stone are quoted alongside dock. Cement delivered to contractors on job. **Chicago** quotes hydrated lime in 50-lb. bags. **Minneapolis** quotes on fir instead of pine. Brick and hollow tile delivered. Cement on cars; $2.60 delivered. Gravel, sand and crushed stone quote at pit. We quote on brown lime; white is $1.70 for Kelly Island and $1.65 for Sheboygan. Common labor not organized. **Denver** quotes cement "on tracks"; gravel and sand at pit, stone on cars, lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered. **Atlanta** quotes sand, stone and gravel per ton instead of cu.yd. **Dallas** quotes lime per 180-lb. bbl. Steel, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered. **San Francisco** quotes on Heath tile, 5½ x 8 x 11½. Prices are all f.o.b. warehouses except C. I. pipe, which is mill price plus freight to railway depot at any terminal. Lumber prices are delivered "at ship tackle in San Francisco ex mill." **Seattle** quotes on Douglas fir instead of pine; and on lime in paper bags. **Montreal** quotes sand, stone, gravel and lump lime per ton. Cement, lime and tile are delivered; sand, gravel and stone, on siding; brick f.o.b. plant; steel and pipe at warehouse. Cement price is in Canadian funds, exchange with the United States being 14 per cent at present. Bag change is 80c. per bbl. Discount of 10c. per bbl. for payment within 20 days from date of shipment.

Changes Since Last Week

Structural steel shapes are quoted at $1.70@$1.75, Pittsburgh; with reinforcing bars selling at $1.65@$1.70. Steel plates are quoted as low as $1.60 @$1.70 per 100 lb. Mill shipments, New York, of structural shapes are quoted at $2.03@$2.18; plates at $2.03 @$2.08 and reinforcing bars at $2.03 per 100 lb. Warehouse prices on steel shapes, rivets and bars have remained firm throughout the week. Increases in discounts, ranging from 2 to 6 per cent on black steel pipe, are reported in Chicago, Minneapolis, Denver and Seattle. Cast-iron pipe has dropped $5 in Seattle, $3 in Minneapolis and advanced $4 per ton in New York.

Cement prices have dropped 20c. in San Francisco and Chicago, 15c. in Minneapolis and 10c. per bbl. in New York. Chicago quotes sand and gravel at $1.65 as against $1.80 per cu.yd. and crushed stone at $1.75 as compared with $2 per cu.yd. last week.

Long leaf yellow pine has dropped $2 in San Francisco, making the present price $28 as against $30 per M. ft.

Chicago reports slight reductions in hollow tile and quotes hydrated finishing lime at $18 as compared with $20 per ton formerly. Common lump lime has dropped 10c. in Minneapolis and 15c. per bbl. in Chicago. An advance of 2c. in linseed oil is reported in New York, 3c. in Chicago and 5c. per gal. in Minneapolis.

Common labor, non-union, is available at 35@40c. per hour in Denver and Chicago. The building trades' situation in San Francisco is rapidly approaching a normal basis, for this time of the year.